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DISTRIBUTION OF RIVER OTTERS IN CALIFORNIA,

WITH DESCRIPTION OF A NEW SUBSPECIES

BY
JOSEPH GRINNELL

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DISTRIBUTION OF RIVER OTTERS IN CALIFORNIA,

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BY

JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

River otters (genus *Lutra*) are still known to occur at irregular intervals in the streams of northern and central California. The southernmost ascertained point of occurrence in the coast belt is a creek flowing into one of the heads of Drake Bay, near Point Reyes, Marin County. In the great Sacramento–San Joaquin Valley there are definite reports of otters from various streams and sloughs south as far as near Lane Bridge, north of Fresno, in that portion of the San Joaquin River forming the boundary between Fresno and Madera counties. There are rumors of occurrence still farther south, namely in certain streams making down from the high southern Sierra Nevada; but there is as yet no acceptably authenticated instance. There are no records at hand from the coast belt south of San Francisco Bay and none from the San Diegan district.

Otters are stated to be "occasionally caught in the Colorado River," along the southeastern border of California (Stephens, 1906, p. 234). The writer just cited refers to the Colorado River animal under the name *Lutra canadensis sonora* Rhoads, apparently assuming its identity with the form described from a tributary of the Gila River, in Yavapai County, Arizona. This assumption is probably correct, and the form *sonora* should not have been omitted, as it was, from my distributional list of the mammals of California (Grinnell, 1913, p. 297). However, I am unable at this time to add any corroborative

evidence either as to the occurrence of otters in the Colorado River, or as to the status of the form there represented. It is practically certain that decided differences exist between the race occurring to the west beyond the broad expanse of waterless desert and that of the Colorado basin. Rhoads' description of *sonora* comes near to providing clear proof of this, although he had evidently not had the opportunity to make comparisons with the Californian animal. Unfortunately, the present writer has no specimens of *sonora* for examination

Returning again to the river otter of central and northern California, there are in the California Museum of Vertebrate Zoology seven specimens from this area, as follows: one (no. 4975), skin only, from John's Camp, McCloud River, Shasta County, secured by E. L. Furlong; one, skull only (no. 12653), from Price Creek, tributary to Eel River, Humboldt County, obtained by F. Stephens; two, skulls only (nos. 19153, 19154), and two, skins with skulls (nos. 19098, 19152), from Cuddeback, on tributary of the Eel River, Humboldt County, all taken by H. E. Wilder; and one, skin with complete skeleton (no. 20775), from Grizzly Island, Solano County, secured by Miss A. M. Alexander. In studying this Californian material the writer has had access to twenty-one other specimens from Alaska, two from Queen Charlotte Islands, British Columbia, one from Vancouver Island, British Columbia, and two from Klamath County, Oregon, all this material being also contained in this Museum; and three additional skulls from Oregon, two from McKenzie River, Lane County, and one from Bend, Crook County, kindly loaned the writer from the Oregon State Fish and Game Office by Mr. Stanley G. Jewett.

It is believed that the above specified material, in conjunction with the published measurements, plates, and descriptions by Rhoads (1898, pp. 423–439, pls. 24, 25) suffices for determining the systematic status of the California river otter. After an appropriate examination of the facts in the case I am led to conclude that we have here an additional distinct subspecies, which requires naming.

Lutra canadensis brevipilosus, subsp. nov.

California River Otter

Type.—Female adult, skin and complete skeleton, no. 20775, Mus. Vert. Zool.; Grizzly Island, Solano County, California; January 26, 1914; secured from a local trapper by Miss Annie M. Alexander, and presented by her to the Museum.

Diagnostic Characters.—Similar to *L. c. pacifica* and *L. c. periclyzomae*, but general size greater, pelage shorter, coloration paler, and proportions of skull different, the cranium for one thing being narrower and higher.

Description of Type.—Weight before skinning, 16 pounds, 10 ounces. Total length, 1158 millimeters; caudal vertebrae, 447; hind foot, 123.5; height of ear from crown, 20; ear from notch, 23.8. Length of hair: on middle of back, 21; top of head between ears, 11; top of tail along median line half-way toward tip, 20.5; middle of belly, 16.4. Length of fur: on middle of back, 13.8; top of head, 8.1; top of tail, 9; belly, 9.8. Coloration (nomenclature, that of Ridgway's *Color Standards*, 1912): above bister, with hairs distinctly paler tipped, giving a grizzled effect, gradually paling around sides to Saccardo's umber on lower surface of body and tail; this further paling anteriorly to avellaneous on throat and to tilleul-buff on chin and upper lip; tops of fore and hind feet snuff brown; whiskers chiefly whitish. Skull small (see table of measurements); rostral portion relatively both narrow and shallow; braincase narrow and high: ratio of height of skull at bulla to mastoid breadth 64 per cent; dentition light.

Remarks.—*Lutra c. pacifica* Rhoads (1898, p. 429), type from Lake Keechelus, Kittitas County, Washington, is evidently a large race, very similar to *L. c. periclyzomae* Elliot (1905, p. 80), type from Queen Charlotte Islands, British Columbia. The differences between these two must be very slight. In fact Heller (1909, p. 262), after examining good series in the national collections at Washington, was able to find but one "reliable character" to distinguish *periclyzomae* from *pacifica*, namely "the extreme flatness of the audital bullae." The bullae of *brevipilosus* are much smaller, but relatively somewhat more elevated, than in British Columbian examples of *periclyzomae*.

The type of *brevipilosus* is extreme in all skull characters (see pl. 14), so that it probably represents the farthest southern divergence of the Pacific Coast series of forms. The Humboldt County specimens are very similar, as shown in the table of measurements herewith given of Californian skulls. The five Oregon skulls are somewhat intermediate towards the *pacifica-periclyzomae* style; but because of their small size I should apply the name *brevipilosus* to them, along with all the Californian specimens. Characters of pelage and color are likely to prove intermediate also, though this surmise is practically worthless in absence of skins from Oregon and Washington. The three

List and Measurements in Millimeters of Skulls of *Lutra canadensis brevipilosus* from California

Mus. No.	Sex Age	Locality	Basilar length of Hensel	Condylo-basal length	Zygomatic breadth	Mastoid breadth	Least width of rostrum	Interorbital constriction	Postorbital constriction	Postpalatal constriction	Height of braincase at bullae
12653	? yg.	Price Creek, Humboldt County	97.4	106.4	70.9	64.7	25.5	22.9	20.3	14.7	41.8
19098	♂ ad.	Cuddeback, Humboldt County	97.9	106.3	73.4	66.5	26.1	22.7	19.5	14.2	41.7
19152	♂ ad.	Cuddeback, Humboldt County	100.1	109.5	75.3	67.1	27.0	24.9	20.0	14.0	41.1
19153	♂ yg.	Cuddeback, Humboldt County	101.0	110.4	71.7	65.1	26.7	24.3	19.7	13.5	40.1
19154	♂ ad.	Cuddeback, Humboldt County	97.4	106.7	72.1	66.7	26.4	26.2	19.0	13.8	41.2
20775*	♀ ad.	Grizzly Island, Solano County	98.5	106.8	70.0	64.9	24.3	23.5	21.0	13.7	41.6

* Type.

other skins from California are almost identical in these respects with the type of *brevipilosus*. All are full-pelaged winter skins.

As for name, the only synonym apparently requiring consideration is the "*Lutra californica* Gray," and this seems to have been disposed of with finality by Thomas (1889, p. 198), as applying to a South American form of remote relationship.

The type locality of *brevipilosus* is in the lowland area at the confluence of the Sacramento and San Joaquin rivers. In the included Suisun marshes are many sloughs in which the water varies, according to the tide and the stage of water in the rivers, from salt to nearly fresh, averaging brackish. From information obtained by Miss Alexander, as well as from other sources, river otters would appear to be even at the present time common along these channels. At least six are reported to have been killed in the vicinity the past winter. Good evidence is at hand that otters have occurred recently across the Suisun marshes as far west as Cordelia Slough.

Transmitted June 27, 1914.

LITERATURE CITED

Elliot, D. G.
1905. Descriptions of three apparently new species of mammals. Proc. Biol. Soc. Wash., **18**, 79–82.

Grinnell, J.
1913. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., **3**, 265–390, pls. 15, 16.

Heller, E.
1909. The mammals, *in* "Birds and mammals of the 1907 Alexander expedition to southeastern Alaska." Univ. Calif. Publ. Zool., **5**, 245–264, pl. 26, 2 figs. in text.

Rhoads, S. N.
1898. Contributions to a revision of the North American beavers, otters and fishers. Trans. Amer. Philos. Soc., n.s., **19**, 417–439, pls. 21–25.

Stephens, F.
1906. California mammals (San Diego, West Coast Publishing Co.), 351 pp., frontispiece, many figs. in text.

Thomas, O.
1889. Preliminary notes on the characters and synonymy of the different species of otter. Proc. Zool. Soc. London, **1889**, 190–200.

PLATE 14

Dorsal and ventral views of skull of *Lutra canadensis brevipilosus*; type, ♀ adult, no. 20775, Mus. Vert. Zool., Grizzly Island, Solano County, California. × 1.


20775

UNIVERSITY OF CALIFORNIA PUBLICATIONS
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FOUR NEW POCKET GOPHERS FROM CALIFORNIA

BY

JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The pocket gophers (genus *Thomomys*) offer an interesting problem in distribution and speciation. Reduced power of locomotion appears to have accentuated the action of barriers. Particularly in California, where topographical and climatic conditions are so varied, has differentiation of species proceeded to an extreme degree.

For the past seven years, particular attention has been paid by the staff of the California Museum of Vertebrate Zoology to obtaining material in this group, with the result that we now have 1749 specimens from localities within the state. But even this amount of material is far from sufficient for exhaustive and accurate treatment. There is, however, sufficient ground for placing on record at this time characterizations of certain new species and subspecies.

During a recent visit to this museum, Mr. Vernon Bailey, of the United States Department of Agriculture, went over our gophers for the purpose of gathering distributional data contributory to a revision of the North America gophers which he now has under way. The writer was privileged to work over part of the material with Mr. Bailey, and submit to him various questions. The validity of the supposed new forms was discussed, and during these discussions some of the writer's impressions were emended or corrected. The writer takes this opportunity to thank Mr. Bailey for his friendly and helpful suggestions in these regards.

Thomomys monticola premaxillaris, new subspecies

Yolla Bolly Gopher

Type.—♂ adult, no. 20242, Mus. Vert. Zool.; two miles south of South Yolla Bolly Mountain, altitude about 7500 feet, in Tehama County, California; August 6, 1913; collected by G. F. Ferris; original no. 166.

Diagnosis.—A member of the *monticola* series of gophers; palest of the forms known from California. Feet and ears small; premaxillary tongues extending far back of posterior ends of nasals; interparietal relatively broad antero-posteriorly.

Material.—Twenty-five specimens (nos. 20223–20247), from three localities in Tehama County, in the vicinity of South Yolla Bolly Mountain: two miles south of South Yolla Bolly, about 7500 feet altitude; four miles south of South Yolla Bolly, about 6000 feet altitude; Mount Linn (South Yolla Bolly of residents of the region), about 7600 feet altitude. All these localities are in Canadian or high Transition Zone; semi-arid in faunal condition; and on gravelly mountain slopes in coniferous forest association.

Measurements.—Of type (old adult male): Total length, 215 mm.; tail, 59; hind foot, 27; occipito-nasal length of cranium, 37.5; zygomatic width, 20.8; mastoid width, 18.6; height of braincase at bullae, 11.1. The hind foot averages, in thirteen adults of *premaxillaris*, 26.8 mm.

Comparison.—From near topotypes of *Thomomys monticola monticola* Allen, from the central Sierra Nevada, in Eldorado County, California, the new form differs in paler coloration (above close to ochraceous-tawny [of Ridgway, 1912], below light ochraceous-buff), in smaller ear, shorter hind foot, in slightly shorter and narrower rostrum of skull, in greater development of temporal ridges and in closer and more nearly parallel approximation of these, in extension of premaxillary tongues far back of posterior ends of nasals, and in shape of interparietal which is on an average relatively much broader antero-posteriorly. From topotypes of *T. monticola pinetorum* Merriam, *premaxillaris* differs in slightly paler coloration, in shape of interparietal, which averages very slightly broader antero-posteriorly, and in all other respects as from *T. m. monticola*. It may be remarked that the differences distinguishing *pinetorum* and *monticola* are at best extremely slight.

Thomomys diaboli, new species

Diablo Gopher

Type.—♀ adult (contained five embryos), no. 14165, Mus. Vert. Zool.; Sweeney's Ranch, in hills of Diablo Range twenty-two miles south of Los Baños, Merced County, California; April 2, 1911; collected by C. H. Richardson and H. A. Carr; original no. 108.

Diagnosis.—A member of the *bottae* series of gophers; smallest of all the forms so far known from west-central California; nearest in color to *Thomomys angularis angularis* Merriam, but slightly darker brown, especially beneath; other characters: small ears and feet, very weak and narrow rostrum, small teeth, moderately projecting incisors, and short nasals.

Material.—Seven specimens (nos. 14160–14165, 14696) from the type locality, as above; one (no. 16676) from top of divide on wagon road, 3000 feet altitude, in the Temblor Range, eleven miles west-northwest of McKittrick, Kern County, California. The latter specimen shows slight peculiarities of color and cranium, but is much nearer *diaboli* than any other form. In both places the zone is Upper Sonoran; rather arid; hillside juniper association.

Measurements.—Of type (adult female): total length, 180 mm.; tail, 60; hind foot, 25; occipito-nasal length of cranium, 32.9; zygomatic width, 22.0; mastoid width, 17.9; height of braincase at bullae, 11.6; length of nasals, 10.3. Total length of six adults: 180 to 193, average 189.

Comparisons.—From *Thomomys bottae bottae* (Eydoux and Gervais), of the San Francisco Bay region, the new form differs in very much smaller size, less blackish, more reddish, coloration, relatively smaller feet, smaller teeth, and weaker rostrum. From topotypes of *T. angularis angularis* Merriam, *diaboli* differs in much smaller size, relatively smaller feet and ears, slightly darker and browner coloration, much weaker rostrum, narrower incisors and less angular skull. From *T. leucodon navus* Merriam, of the Sacramento Valley, *diaboli* differs in slightly darker coloration, smaller size, much smaller molar teeth, smaller auditory bullae, much shorter nasals and narrower rostrum. From *T. nigricans nigricans* Rhoads, of the coast ranges of San Diego County, *diaboli* differs in slightly paler coloration, and notably in cranial characters: the nasals are much shorter, the incisors project far more, and the braincase is broader and more inflated

parietally. *Diaboli* is much like topotypes of *T. mewa* Merriam in size and coloration, though not quite so reddish in corresponding pelage, but differs in longer tail, and cranially in more bulging braincase, shorter nasals, and much more projecting incisors.

Thomomys infrapallidus, new species

Carrizo Plain Gopher

Type.—♂ old adult, no. 14181, Mus. Vert. Zool.; seven miles southeast of Simmler, Carrizo Plain, San Luis Obispo County, California; May 25, 1911; collected by H. S. Swarth; original no. 9138.

Diagnosis.—A member of the *bottae* series of gophers; palest of all the forms of this series so far as known from west-central California; nearest in color to *Thomomys angularis pascalis* Merriam, but decidedly paler beneath; other characters: relatively large feet, long fore claws, long tail, narrow and high braincase, moderately spreading zygomatic arches, moderately projecting incisors, small molar teeth, and very small auditory bullae.

Material.—Nine specimens (nos. 14179–14187, Mus. Vert. Zool.), all from Carrizo Plain, San Luis Obispo County, California: six from seven miles southeast of Simmler, and three from five miles north of Painted Rock; all collected in May, 1911, by H. S. Swarth. The altitude of the Carrizo Plain varies from 1900 to 2500 feet. Faunally and zonally it may be considered very arid, high Lower Sonoran. A sparse prairie vegetation grows on ground that is more or less strongly alkaline over most of the area.

Measurements.—Of type (old adult male): total length, 248 mm.; tail, 76; hind foot 34; occipito-nasal length of cranium, 43.0; zygomatic width, 29.0; mastoid width, 22.8; height of braincase at bullae, 14.0.

Comparisons.—From topotypes of *Thomomys bottae pallescens* Rhoads, the new form differs at a glance in much smaller auditory bullae, smaller and slenderer teeth, and more anteriorly projecting incisors. From *T. bottae bottae* (Eydoux and Gervais), *infrapallidus* differs in very much paler, more clayey, coloration, smaller general size, larger feet, longer tail, much smaller teeth, and smaller bullae. From topotypes of *T. angularis angularis* Merriam, *infrapallidus* differs in smaller size, paler coloration, especially below, narrower

braincase, and less squarely spreading zygomatic arches. From topotypes of *T. a. pascalis* Merriam, *infrapallidus* differs in paler coloration ventrally, larger feet, higher braincase, more projecting incisors and smaller auditory bullae.

Thomomys nigricans puertae, new subspecies

La Puerta Gopher

Type.—♂ young adult, no. 7511, Mus. Vert. Zool.; La Puerta (Mason's Ranch), eastern San Diego County, California; May 31, 1909; collected by F. Stephens; original no. 1974.

Diagnosis.—A pale desert-slope race of *Thomomys nigricans nigricans* Rhoads; apparently identical in size and cranial characters with that race; pelage mid-dorsally and around ears with far less admixture of black; general tone of coloration both above and below, ochraceous-tawny (of Ridgway, 1912), brightest on sides, and slightly subdued with dusky down middle of back; spot of sooty behind ear; face dusky.

Material.—The Museum contains forty-three specimens labelled La Puerta (nos. 7510–7519, 7582–7586, 16636–16654, 18822–18830). These are all of Mr. Stephens's collecting. According to his field notebook, the majority were caught in cultivated land on Mason's Ranch, which is located at the lower end of La Puerta Valley. Others, however, were taken on surrounding hillsides. Mason's Ranch is five miles west of Vallecito, on the old overland (Butterfield) stage-road. La Puerta Valley is evidently arid Lower Sonoran. Along the course of the stream arrowweed (*Pluchea*) is a common plant, while there is an occasional mesquite. The valley floor is mostly covered with large creosote bushes (*Larrea*).

Comparisons.—The series of La Puerta gophers is notably variable in color-tone. Picked specimens are fully as dark as the average of topotypes of *nigricans*, from Witch Creek, on the west side of the Cuyamaca Mountains. La Puerta is well down on the desert or east slope of the same general mountain mass, and less than ten miles away, so that it is quite possible that a continual invasion of true *nigricans* down on the east slope brings good examples of that form into the same valley with the more remotely derived and hence differentiated type here named *puertae*. Upon this theory the series at hand may be divided into bright-colored and dark-colored sections, the former meriting the name *puertae*, the latter *nigricans*.

It is obvious that *puertae* is a local, arid Lower Sonoran race of *nigricans,* the latter belonging to the closely-adjacent semi-humid Upper Sonoran of the various coast ranges of San Diego County, mostly on their western slopes. Typical *puertae,* as compared with typical *nigricans,* shows, in addition to the characters given above, a tail of uniform pale tawny color both above and below, instead of dusky above at base. From *T. cabezonae* Merriam, possibly also a subspecies of *nigricans, puertae* differs in more tawny coloration above (this obtaining in small young as well as in adults), invasion of tawny over under surface, more depressed rostral region of cranium, narrower interorbital constriction and braincase, and more widely spreading zygomata. From *T. bottae pallescens* Rhoads, *puertae* differs in smaller size, paler, more tawny coloration, lighter dentition, weaker and more depressed rostrum and smaller auditory bullae.

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THREE NEW RACES OF VESPERTILIONID BATS FROM CALIFORNIA

BY

HILDA WOOD GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

During the past six years there has been accumulated in the Museum of Vertebrate Zoology a collection of eight hundred and thirteen specimens of bats from within the boundaries of California. Although material is still lacking from many important localities within the state, there is now at hand in several instances a sufficient number of specimens to show clearly the existence of certain hitherto unnamed races. Three of these new races are described below. In these descriptions all measurements are given in millimeters; total length, tail vertebrae and foot measured in the flesh by the collector. Color descriptions are based upon Ridgway's *Color Standards and Nomenclature* (1912).

The writer's thanks are due to Mr. Henry W. Henshaw, Chief of the Bureau of Biological Survey, United States Department of Agriculture, and to Mr. John Rowley, Curator of Mammals, California Academy of Sciences, for the loan of pertinent material used in comparisons.

Myotis californicus quercinus, new subspecies

Oak Foliage Bat

Type.—Female, adult; no. 6939, Mus. Vert. Zool.; Seven Oaks, 5000 feet altitude, San Bernardino Mountains, San Bernardino County, California; July 8, 1905; collected by J. Grinnell; original no. 1120.

Diagnosis.—Similar to *Myotis californicus californicus* (Audubon and Bachman) and *Myotis californicus pallidus* Stephens, but intermediate in color between these two forms. Prevailing tone of color on back, cinnamon.

Description.—Ears, feet and fur as in *M. c. californicus.* Membranes and bases of hairs everywhere as in *californicus.* On the back the terminal portions of the fur are glossy cinnamon, and this color extends down onto the sides. The terminal portions of the hairs below are light buff in color, rather than buffy-brown as in *californicus,* or pale cartridge-buff as in *pallidus.*

Measurements.—A series of ten examples of *M. c. quercinus* from southern California averages in millimeters as follows: Total length, 81.6 (77.0–83.0); tail vertebrae, 36.8 (31.0–41.0); tibia, 14.1 (12.5–15.0); foot, 6.0 (4.0–8.0); forearm, 31.9 (31.0–33.2); greatest length of cranium, 13.1 (12.9–13.8); zygomatic breadth, 7.7 (7.4–8.0); breadth of braincase, 6.8 (6.6–7.0); interorbital constriction, 3.0 (2.9–3.3).

Specimens examined.—The writer has examined twenty-two specimens of *Myotis californicus quercinus* from the following localities in California: San Diego County—Cuyamaca, 2, Julian, 5; Santa Cruz Island—Friar's Harbor, 3; San Bernardino Mountains, San Bernardino County—Seven Oaks, 2, Bear Lake, 1, South Fork Santa Ana River, 2; San Jacinto Mountains, Riverside County—Kenworthy, 1, Schain's Ranch, 1; Tulare County—Trout Creek, 2; Ventura County—Matilija, 1, Mount Pinos, 2.

Remarks.—The three specimens listed from Santa Cruz Island, while slightly darker than typical *quercinus,* are still nearer to this form than to *M. c. californicus.*

Distribution.—The range of *M. c. quercinus,* as so far worked out, occupies portions of the San Diegan faunal division of southern California, and the Santa Barbara Islands. The life-zone is high Upper Sonoran and low Transition. The bats appear at late twilight and are usually observed flitting close about the foliage of scrub, golden, and black oaks.

Myotis yumanensis sociabilis, new subspecies

Tejon Bat

Type.—Female, adult; no. 5158, Mus. Vert. Zool.; Old Fort Tejon, 3200 feet altitude, Kern County, California; July 23, 1904; collected by J. Grinnell; original no. 715.

Diagnosis.—Similar in general characters to *Myotis yumanensis yumanensis* (H. Allen) and *Myotis yumanensis saturatus* Miller, but intermediate in color between these two forms.

Description.—The fur is distributed as in topotypes of *M. y. yumanensis.* On middle of back it averages about six millimeters in length. Hairs everywhere clove brown at base; distal half of fur on dorsal surface wood brown; fur below light buff, with darker bases of hairs showing through. On throat, sides and chin the color varies toward warm buff; ears olive brown; feet, wings and tail-membranes clove brown. The young are darker and grayer throughout, entirely lacking the buffy tint of the adults.

Measurements.—A series of five adult males of *M. y. sociabilis* averages in millimeters as follows: Total length, 81.4 (75.0–87.0); tail vertebrae, 33.3 (30.0–37.0); tibia, 15.2 (15.0–16.0); foot, 8.1 (7.0–10.0); forearm, 34.6 (32.9–35.3); greatest length of cranium, 13.7 (13.5–14.4); zygomatic breadth, 8.4 (8.0–8.6); breadth of braincase, 7.1 (6.7–7.6); interorbital constriction, 3.8 (3.5–3.9).

Ten adult females from Old Fort Tejon, Kern County, average in millimeters as follows: Total length, 81.9 (76.0–85.0); tail vertebrae, 36.6 (34.0–37.0); tibia, 14.7 (13.5–16.0); foot, 8.9 (8.0–10.0); forearm, 34.2 (33.7–35.0); greatest length of cranium, 13.8 (13.4–14.2); zygomatic breadth, 8.1 (7.8–8.3); breadth of braincase, 7.2 (6.7–7.3); interorbital constriction, 3.7 (3.6–4.0).

Specimens examined.—Total number sixty-nine, from the following localities in California: Butte County—Chambers Ravine, four miles north of Oroville, 1; Glenn County—Winslow, five miles west of Fruto, 1; Kern County—Old Fort Tejon, 61, Buttonwillow, 1 (Calif. Acad. Sci.); San Bernardino County—Bluff Lake, 7500 feet altitude, 3, Bear Lake, 6700 feet altitude, 1, South Fork Santa Ana River, 8500 feet altitude, 1.

Remarks.—Specimens of *M. y. sociabilis* from the San Bernardino Mountains show strong superficial resemblance to the smaller individuals among a series of *Myotis longicrus* (True) from the same locality. The longer tibia of the latter species, however, together with the slightly greater size of skull and the more elevated occipital region, serves to allocate individuals.

Distribution.—The distribution of this bat cannot be stated with confidence without much further field-work. It appears to occupy an intermediate geographic position between that of *M. y. yumanensis* and *M. y. saturatus*, namely the semi-arid Transition and Sonoran zones in California west and north of the southeastern deserts.

Corynorhinus macrotis intermedius, new subspecies

Intermediate Lump-nosed Bat

Type.—Female, adult; no. 7753, Mus. Vert. Zool.; Auburn, 1300 feet altitude, Placer County, California; July 31, 1909; collected by Dr. J. C. Hawver; original no. 2387, J. Grinnell.

Diagnosis.—Similar in general characters to *Corynorhinus macrotis pallescens* Miller and *Corynorhinus macrotis townsendi* (Cooper), but intermediate in color between these two forms.

Description.—As compared with *pallescens*, *intermedius* is somewhat larger in general size; ten examples of the latter form from Auburn, Placer County, average 102 millimeters in length, while ten specimens of *pallescens* from the San Jacinto region average but 97.2 in the same dimension. In color *intermedius* is natal brown above; below, wood brown; membranes bone brown.

Measurements.—A series of ten specimens from west central California averages in millimeters as follows: Total length, 102 (97.0–108.0); tail vertebrae, 48.6 (45.0–55.5); tibia, 19.7 (18.7–21.0); foot, 9.8 (9.0–12.5); forearm, 42.0 (40.2–43.6); greatest length of skull, 16.2 (15.4–17.1).

Specimens examined.—Total number, thirty-two, from the following localities in California: Placer County—Auburn, 23, Pioneer Cave, 3; Santa Catalina Island—Johnson Harbor, 1; Napa or Sonoma County—Mount Veeder, 1 (U. S. Biol. Surv.); Siskiyou County—Happy Camp, 1 (U. S. Biol. Surv.); San Benito County—Bear Valley, 2 (U. S. Biol. Surv.), Hernandez, 1 (Calif. Acad. Sci.).

Distribution.—The evidence at hand indicates that this bat occupies a geographic position intermediate between that of *pallescens* and that of *townsendi*, namely the semi-arid and semi-humid portions of the Upper Sonoran zone in California west of the desert divides.

Transmitted October 6, 1914.

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EUTAMIAS SONOMAE, A NEW CHIPMUNK FROM THE INNER NORTHERN COAST BELT OF CALIFORNIA

BY
JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The considerable series of chipmunks (genus *Eutamias*) in the California Museum of Vertebrate Zoology, accumulated from the coast district of California north of San Francisco Bay, consists of three distinct species. Two of these, *Eutamias hindsi* (Gray) and *Eutamias townsendi ochrogenys* Merriam, are already well known. The third is herewith described, and the opportunity is taken to give the distribution of all three species, as shown by the series of specimens at hand. In this connection, there have been available for comparison, through the courtesy of Mr. Henry W. Henshaw and Mr. Vernon Bailey, of the United States Biological Survey, forty-six additional specimens of *Eutamias hindsi*, from the national collection at Washington. Color names are taken from Ridgway's (1912) *Color Standards and Nomenclature*.

Eutamias sonomae, new species

Sonoma Chipmunk

Type.—♀ adult, in full summer pelage; no. 20825, Mus. Vert. Zool.; one mile west of Guerneville, Sonoma County, California; July 12, 1913; collected by J. and H. W. Grinnell; orig. no. 2250.

Diagnosis.—A member of the *townsendi* group of chipmunks (see Merriam, 1897, p. 194); nearest like *Eutamias hindsi*, from which it differs in greater size, relatively longer tail, longer ears, less deeply ferruginous tone of coloration dorsally, whiter lower surface, the three dorsal black stripes narrower, outermost light stripes whiter, post-

auricular spots larger and whiter, top of head and rump grayer in tone, and tail hairs distinctly tipped with gray.

Description.—Adult summer, or post-breeding, pelage (from type): Under parts from chin to base of tail, white, with creamy tinge mid-ventrally; insides of thighs and arms, light ochraceous-buff; upper surface of feet, dull ochraceous-tawny; sides and general suffusion over back, bright cinnamon-rufous, approaching apricot-orange in tone along the lower sides; narrow black median stripe from between ears to rump, fading out near base of tail; rest of dorsal stripes much shorter, not extending forward of shoulders; median dorsal stripe bordered on each side by a gray line, this much obscured with ferruginous; outwardly of gray stripe on each side is a black stripe dulled by intermixture of ferruginous hairs; succeeding this outwardly is a conspicuous clear ashy-white stripe on each side, and outwardly to this a much shorter stripe of dusky along the upper edge of the otherwise bright cinnamon-rufous side. There are thus three black stripes and four light stripes, the outermost pair of which is conspicuously whitish (much more clearly so than in *hindsi*). Rump and flanks, grizzled Brussels brown; tail beneath, bright Sanford's brown, outwardly margined with black and ashy white; tail dorsally black, with a little of the ochraceous-orange bases of the hairs showing through, and grizzled with the ashy-white hair tippings. Ears lightly lined inwardly with hazel hairs; front half of outer surface of ear, dull cinnamon-rufous, posterior half light mouse gray; triangular spot behind each ear, clear white, slightly tinged with ashy, but much more conspicuous than in *hindsi;* top of head grizzled grayish brown; head stripes more brightly contrasted with each other than in either *hindsi* or *ochrogenys;* stripes from nose to base of ear, above and below eye, white, slightly dulled with black and ferruginous hairs; a dusky stripe above each whitish supra-ocular stripe, becoming blacker anteriorly and meeting its fellow on tip of nose; a black stripe, dulled by ferruginous, from eye to base of ear; a similarly colored but narrower stripe beneath the whitish subocular stripe; a dull brownish suffusion between eye and snout; whiskers black. Measurements of type: total length, 260 mm.; tail vertebrae, 112; hind foot, 36; ear from crown, 17. Thirty adult specimens of *sonomae* average, as measured by field collectors: total length, 251 mm.; tail vertebrae, 113; ratio tail to body, 82 per cent. Eighteen adults of *hindsi* average: total length, 232 mm.; tail vertebrae, 102; ratio tail to body, 78 per cent. Cranial differences are not apparent. Breeding (worn winter) pelage: pattern

the same as above, but much duller in tones of color and hence with less of contrast; compared with corresponding stage in *hindsi,* grayer, less reddish; lower surface white instead of buffy; brown of tail much less reddish in tone, more ochraceous; dimensions diagnostic.

Distribution.—Of *Eutamias sonomae* there are 68 specimens in the Museum of Vertebrate Zoology, representing localities as follows: 5 miles south of Kunz, Trinity County, 1; Line Creek, 5500 ft. alt., 1 mile east of Castle Peak, near Trinity County line, Mendocino County, 1; 3 miles south of Covelo, Mendocino County, 9; 3 miles west of summit of Sanhedrin Mountain, 4500–6000 ft. alt., Mendocino County, 22; Lierly's Ranch, 2340 ft. alt., 4 miles south of Sanhedrin Mountain, Mendocino County, 2; 6 miles north of Willits, 1400 ft. alt., Mendocino County, 2; Rumsey, 500 ft. alt., Yolo County, 3; 8 miles west of Vacaville, Solano County, 5; 1 mile west of Guerneville, Sonoma County, 6; 7 miles west of Cazadero, Sonoma County, 15; Freestone, Sonoma County, 2.

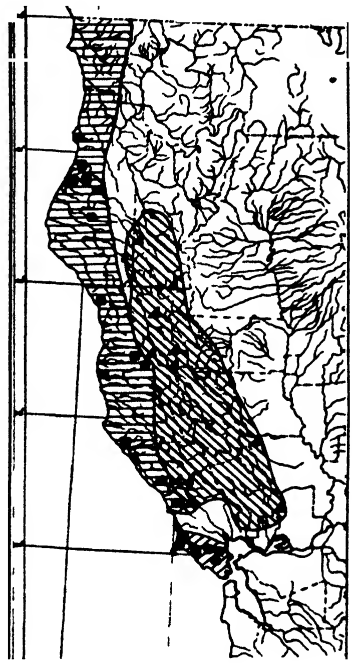

Fig. 1. Map of portion of northwestern California, north from San Francisco Bay, showing record stations and approximate ranges of *Eutamias townsendi ochrogenys*, *Eutamias sonomae*, and *Eutamias hindsi*.

Of *Eutamias townsendi ochrogenys* there are 129 specimens in this Museum, distributed as follows: Trinidad, Humboldt County, 4; Arcata, Humboldt County, 1; Freshwater, Humboldt County, 2; Eureka, Humboldt County, 7; Fair Oaks, Humboldt County, 17; Cuddeback, Humboldt County, 5; Rockport, Mendocino County, 1; Mendocino City, Mendocino County, 22; Sherwood, Mendocino County, 23; 5 miles north of Willits, Mendocino County, 1; Gualala, Mendocino County, 23; 7 miles west of Cazadero, 900 ft. alt., Sonoma County, 12; Freestone, Sonoma County, 11.

Of *Eutamias hindsi* there are available, from the collections of this

Museum and of the United States Biological Survey, 62 specimens, as follows, all from Marin County: Vicinity of Point Reyes, 3 to 5 miles west of Inverness, 12; Inverness, 5; Olema, 15; Lagunitas, 2; "Nicasio" (probably in near vicinity of San Geronimo), 26; Mailliard, 2.

Relationships and Ecology.—*Eutamias sonomae* shows itself to belong primarily to the Upper Sonoran and lower Transition zones, chiefly in the chaparral association, though locally invading the margins of the forest. The species further belongs to what has been called the Clear Lake subfauna, namely, the aggregation of animal species occupying the semi-humid inner coast ranges and intervening valleys, lying between the narrow coastal Redwood fauna on the west and the Sacramento fauna on the east, and extending from the vicinity of San Pablo and Suisun bays north into western Trinity County. *Eutamias hindsi* has similar zonal and associational restriction, but belongs to a more humid area, namely, that occupied by the Marin subfauna. This is a section of the coast belt proper, lying entirely within Marin County, and extending from Point Reyes eastwardly to include the slopes and foothills of Mount Tamalpais. *Eutamias townsendi ochrogenys* belongs to the Transition and Boreal zones in their narrow, humid-coast, faunal divisions. It is a dweller in chaparral and forest, and has not been found south of Freestone, Sonoma County. At the latter point *sonomae* and *ochrogenys* have been taken in the same lines of traps, as also at a point about seven miles west of Cazadero, Sonoma County. The ranges of these two chipmunks thus not only meet, but actually overlap to a slight extent. On the other hand, the range of *hindsi* is separated from the ranges of both *ochrogenys* and *sonomae* by a belt of country apparently unfit associationally for the existence of any one of this group of chipmunks. *Hindsi* is thus quite isolated from any of its relatives (see fig. 1).

It may be remarked that *hindsi* appears to be much nearer in aggregate of characters to *ochrogenys* than is *sonomae*. The latter is thus an extreme departure from the *townsendi* stock. *Sonomae* reminds one in several respects of *Eutamias quadrimaculatus* of the western flank of the central Sierra Nevada, and the species just named may well be a still further manifestation in the *townsendi* series.

Eutamias merriami pricei, of the Santa Cruz subfaunal area, belongs also to the *townsendi* group. It resembles *sonomae* in general aspect, but differs constantly and markedly in smaller ear, in dull gray instead of white postauricular spot, in light gray instead of

whitish outer side stripe, and in grayer, less brightly reddish, general tone of coloration dorsally. In the latter respect *pricei* differs still more strongly from *hindsi.* The ranges of the two chipmunks last mentioned are separated by San Francisco Bay and the Golden Gate, together of course with adjacent strips of territory associationally unfit for habitation by chipmunks.

Transmitted October 31, 1914.

LITERATURE CITED

MERRIAM, C. H.

1897. Notes on the chipmunks of the genus *Eutamias* occurring west of the east base of the Cascade-Sierra system, with descriptions of new forms. Proc. Biol. Soc. Wash., 11, pp. 189–212.

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BATRACHOSEPS MAJOR AND *BUFO COGNATUS CALIFORNICUS*, NEW AMPHIBIA FROM SOUTHERN CALIFORNIA

BY

CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

During the author's examination of the amphibia from southern California contained in the collection of the Museum of Vertebrate Zoology, two forms have been distinguished which seem to deserve recognition under new names.

The occurrence of *Bufo cognatus* almost to the Pacific seaboard in California is of considerable interest, the previous westernmost published record being from the Colorado River. The detection of a new species of *Batrachoseps* in southern California is not to be wondered at, considering the obscurity of the descriptions in the literature relating to this genus. This new salamander is fairly common in the western part of the San Gabriel Valley, especially in the district immediately surrounding Pasadena.

Batrachoseps major, new species

Garden Salamander

Type.—Adult; no. 611, Mus. Vert. Zool.; Sierra Madre, 1000 feet altitude, Los Angeles County, California; March 14, 1909; collected by C. L. Camp; orig. no. 218.

Diagnosis.—A large, pale, long-limbed *Batrachoseps* with light yellow underparts. Costal folds 18, rarely 17 or 19.

Material.—Twenty-nine specimens from Pasadena and Sierra Madre, California; twelve from the latter and seventeen from the former locality; nos. 611, 954–956, 4566–4586, Mus. Vert. Zool.

Comparisons.—This species is intermediate in many of its characters between *Batrachoseps pacificus* from the northern Channel Islands and *Batrachoseps attenuatus* of the Pacific Coast district. Size larger than any of the other species of *Batrachoseps,* not quite so slender as *attenuatus;* head wider; tail shorter and limbs longer than in *attenuatus;* head narrower, tail longer and limbs shorter than in *pacificus.* Van Denburgh (1905, p. 8) states that the number of costal grooves in *B. pacificus* is 17, rarely 16 or 18; this would make the number of costal folds in that species 16, rarely 15 or 17.

To avoid confusion, the system of enumerating the costal folds as here employed should be set forth. For obvious reasons the costal grooves cannot be so accurately ascertained as the folds. The limbs may start in a groove or on a fold and so there may be in many cases fractional folds. These are never considered, only complete folds bounded on each side by grooves being taken into account. This makes the number of grooves always one more than the number of folds.

The costal folds in *B. major* number 18, rarely 17 or 19, the number of folds in *B. attenuatus* (from points in southern and middle California) is 18 or 19, rarely 17 or 20, the number in *B. caudatus* (Hassler Harbor, probably on Annette Island, southeastern Alaska) from the record of Cope (1889, p. 126) is 20 (21 grooves).

B. pacificus, with a wide head, short tail and body, longer limbs and few costal folds, stands nearest the *Plethodon* group of salamanders, while *B. caudatus,* the most specialized member of its genus, with a narrow head, shorter legs, slender body and long tail, lies, both structurally and geographically, at the opposite end of the scale. *B. attenuatus* is intermediate; and *B. major,* representing an apparently restricted local race, is between *pacificus* and *attenuatus* in its proportional measurements (see table, p. 330).

The coloration of the present species resembles that of *pacificus* more than that of *attenuatus.* It is distinct from *attenuatus* by reason of its pale color, especially of the ventral parts, which are yellow and never gray except in narrow transverse areas between the limbs. The dorsal surfaces are slightly paler than in *B. pacificus.* In Van Denburgh's redescription (1905, p. 8) of *pacificus* no mention is made of darker areas between the limbs on the ventral surface such as exist in *major.*

Description of type.—Body and tail elongate, cylindric, annulated; tail conical at tip, stout throughout its length, longer than body; head wider than neck, flat above, narrower than body in abdominal region;

fore and hind limbs do not meet when pressed to sides of body; digits rudimentary, four on both front and hind feet; nostrils separated by nearly twice their distance from the orbits, not terminal, connected with upper lip by thick-edged grooves; gular fold not plainly marked; body divided into eighteen folds, or segments, between the front and hind limbs; skin very smooth and shiny; openings of small pores barely visible on head region. Color in alcohol (from Ridgway's *Color Standards,* 1912) light neutral gray above; sides, lower parts, upper lip, palms and soles near cream buff; slightly darker on under surface of tail and on ventral surface of body transversely between limbs.

Variations.—In the series of twenty-five specimens at hand the costal folds number 17 in four, 18 in seventeen, and 19 in three. In one specimen there are 17 folds on one side and 18 on the other side of the body. In one specimen the outside (fourth) digit of the left front foot is lacking.

Distribution.—This large, light-colored *Batrachoseps* has been taken on south Euclid Avenue beneath boards in a yard, and also in a cellar, in Pasadena, California. The type was found in the neighboring town of Sierra Madre under a broken piece of cement sidewalk, and others taken in the same vicinity were captured in piles of damp lumber and in post-holes. Two were taken in August, 1905, several feet beneath the surface of the ground in loose gravel in a ravine bottom. The localities of capture lie in the upper edge of the Lower Sonoran life-zone (mesa oak association) and below the range of *Batrachoseps attenuatus.* The latter species appears to inhabit the Upper Sonoran zone (maple-sycamore association) in the mountain cañons, possibly getting out into the valleys occasionally along water courses. Both species are entirely terrestrial and both appear to estivate during the drier months, being then seldom found above ground.

COMPARATIVE MEASUREMENTS IN MILLIMETERS OF FOUR SPECIES OF *Batrachoseps*

Mus. no.	Locality[2]	Date	Measured by	Total length	Tail length	Head width	Fore limb	Hind limb	Between limbs	Costal folds	Costal grooves
			Batrachoseps pacificus								
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	45.	20.	3.5	5.	5.5	15.	16?	17?[6]
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	67.	31.	5.	7.	7.5	22.	16?	17?
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	113.	64.	7.	9.	9.5	31.	16?	17?
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	108.	56.	6.5	9.	9.5	36.	16?	17?
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	115.	63.	7.	8.5	9.5	33.	16?	17?
........[3]	San Miguel Island	March, 1903	J. Van Denburgh	115.	59.	8.	9.	10.	38.	16?	17?
........[4]	Santa Barbara(?)	Oct. 28, 1881?	E. D. Cope	71.	36.[5]	4.2	. .	7.4	24.5	18?	....
			Batrachoseps major								
611[1]	Sierra Madre	Mar. 14, 1909	C. L. Camp	134.4	79.5[7]	6.4	7.4	8.2	34.1	18	19
954	Pasadena	Mar. 1, 1905	C. L. Camp	162.0	91.5	6.2	9.5	10.0	43.0	19	20
4568	Pasadena	Mar. 6, 1909	C. L. Camp	64.4	30.7	4.0	6.0	7.1	19.9	18	19
4367	Sierra Madre	May 2, 1908	C. L. Camp	115.5	66.0	5.9	7.1	8.3	30.0	18	19
4584	Pasadena	Dec. 21, 1910	C. L. Camp	108.4	58.5	5.4	7.9	8.3	32.4	19	20
4582	Pasadena	Dec. 21, 1910	C. L. Camp	99.5	57.7	4.6	6.3	7.4	25.5	17	18
4575	Sierra Madre	Dec. 3, 1910	C. L. Camp	74.9	39.6	4.7	5.6	6.8	21.5	18	19
4578	Pasadena	Dec. 21, 1910	C. L. Camp	82.7	37.7	5.1	6.4	7.4	26.5	17	18
			Batrachoseps attenuatus								
2385	Morago Valley, Contra Costa Co.	Feb. 22, 1910	C. L. Camp	111.0	66.3[7]	5.3	5.0	5.6	29.0	19	20
4700	Bailey Cañon, near Sierra Madre	Apr. 18, 1909	C. L. Camp	100.1	60.4	4.1	5.1	5.5	26.8	18	19
4629	2 miles southwest Napa	Dec. 16, 1912	C. L. Camp	74.9	38.6	4.2	5.2	5.7	24.1	18	19
4655	2 miles southwest Napa	Dec. 16, 1912	C. L. Camp	82.5	40.5	4.7	5.5	5.2	25.3	18	19
....	2 miles southwest Napa	Jan. 24, 1915	C. L. Camp	124.2	73.9	4.2	5.5	5.9	35.0	19	20
			Batrachoseps caudatus								
........[4]	Hassler Harbor, Alaska	....	E. D. Cope	160.	103.[5]	6.	6.5	7.	29.5	20	21

[1] Type.
[2] In California unless otherwise stated.
[3] Collection of California Academy of Sciences
[4] Collections of United States National Museum.
[5] Measured from "base of tail."
[6] "In fifty specimens the costal groves are: 17 in forty, 16 in six, and 18 in four"
[7] Measured from posterior end of anus in this series.

Bufo cognatus californicus, new subspecies

Arroyo Toad

Type.—Female, adult; no. 4364, Mus. Vert. Zool.; Santa Paula, 800 feet altitude, Ventura County, California; May 22, 1912; collected by C. L. Camp; orig. no. 551.

Diagnosis.—A toad with divergent head crests, a nasal boss, short, slightly divergent parotoids and with an internal, cutting tubercle on hind foot; femur short as in *Bufo cognatus cognatus*, the Great Plains toad. Size medium; parotoids wide; coloration nearly uniform, without large spots; no vertebral streak; external tubercle on hind foot small and rounded, not provided with a cutting edge.

Material.—Two alcoholic specimens: the type; and adult female, no. 767, Mus. Vert. Zool.; Tujunga Wash, near Sunland, Los Angeles County, California; April 1, 1904; collected by J. Grinnell.

Comparisons.—This *Bufo* is distinct from the common toad (*Bufo halophilus*) of the Los Angeles region, differing from it: in the possession of both transverse and longitudinal cranial crests, in the smaller size, in the absence of a vertebral stripe, in the thick head, and in the more even character of the tuberculation of the back. It is clearly most closely related to *Bufo cognatus cognatus* Say (1823, **2**, p. 190) of Arizona and the Great Plains, east of the Rockies.

The type locality of the latter is the Arkansas River in Colorado, probably between the present site of La Junta, Colorado, and the Colorado-Kansas boundary. *Bufo cognatus* ranges over a large part of the Great Plains district east of the Rocky Mountains, in Colorado, Kansas, Arkansas, New Mexico, Texas, Nebraska, Montana, and South Dakota. West of the Rockies it occurs in northern Mexico, Arizona, and, in southeastern California, along the Colorado River and in the Salton Basin.

The two specimens here included in the subspecies *californicus* are the first representatives of this species known from the Pacific coast of California. They differ from a series at hand of *Bufo cognatus* taken on the Colorado River, in California and Arizona, in the slightly longer hind foot, in the lack of an external cutting tubercle, in the width of the parotoids, which are 10 to 20 per cent broader in *californicus*, and in the type of coloration, which is uniform and without a trace of the large green spots, so pronounced a feature of the coloration of most of the Colorado River examples.

From *Bufo lentiginosus woodhousii,* of the Lower Colorado River district and farther east, the new toad differs decidedly in its smaller size, short hind legs, divergent cranial crests, and in the presence of a bony nasal elevation.

Description of type.—Size medium; hind legs very short, femur almost entirely enclosed in skin of abdomen; head short and thick; nasal region elevated into a bony protuberance; longitudinal cranial crests more or less united across median region, and slightly divergent; transverse crests divided by width of median groove; parotoids oval, slightly divergent and very broad; inner tubercle of hind foot with a sharp edge; outer tubercle very small, rounded and without cutting edge; eyelids and back evenly tuberculated; tympanum oval, shorter than diameter of eye; a dozen or more large whitish tubercles below and just posterior to the tympanum. The color when taken was light olive-green above, with two light patches about six millimeters in diameter immediately behind the parotoids. Upper lip below the eye barred vertically with paler tone; light areas present on eyelids and anterior ends of parotoids. No vertebral stripe present; underparts creamy white, unspotted. Bases of several of the tubercules on the back encircled by small black rings, and no large greenish spots in the dorsal coloration.

Distribution.—The type was found on a lawn in the middle of town, about eight o'clock in the evening. The Santa Paula district is about sixty miles east of the San Fernando Valley (where the other specimen of this subspecies was found), and a mountain spur about one thousand feet in elevation separates the two localities of capture. Both localities lie within the San Diegan faunal area in the Lower Sonoran life-zone, as the latter has been delimited in California. Both localities are of semi-arid character, and the streams are intermittent in the arroyos near which each of these toads was captured.

MEASUREMENTS IN MILLIMETERS OF THE TWO SUBSPECIES OF *Bufo cognatus*

Mus. no.	Sex	Locality[2]	Date	Total length[3]	Head length	Head width	Hind leg[4]	Tibia	Hind foot[5]	Length of parotoid	Width of parotoid
			Bufo cognatus californicus								
4364	♀	Santa Paula, Ventura Co.	May 22, 1912	64.5	19.2	23.5	84.4	26.3	41.5	10.5	7.8
767	♀	Tujunga Valley, Los Angeles Co.	Apr. 1, 1904	58.5	18.0	22.6	83.8	25.9	41.3	11.9	7.4
			Bufo cognatus cognatus								
1139	♂	Needles, San Bernardino Co.	July 16, 1909	60.2	18.0	22.7	80.4	25.0	38.7	8.8	5.5
4361	♂	Needles, San Bernardino Co.	July 16, 1909	59.1	17.9	21.8	75.5	23.6	36.3	8.9	4.9
4358	♀	Needles, San Bernardino Co.	July 16, 1909	60.3	19.0	23.8	81.8	24.7	40.1	9.6	5.2
4360	♀	Needles, San Bernardino Co.	July 16, 1909	62.5	19.4	22.6	78.0	25.1	38.9	9.0	5.5
4363	♂	Needles, San Bernardino Co.	July 16, 1909	62.5	19.1	23.0	81.6	25.9	38.5	9.2	4.6
1137	♂	Needles, San Bernardino Co.	July 15, 1909	58.5	17.7	21.3	76.8	23.1	36.6	8.5	5.2
1134	♂	Needles, San Bernardino Co.	July 16, 1909	63.7	20.0	22.9	78.8?	25.5	38.0?	9.8	5.6
457	♀	Mecca, Riverside Co.	Apr. 21, 1908	64.9	19.4	24.0	79.4	26.0	37.8	9.5	6.1
21070[1]	♂	Ft. Huachuca, Arizona	July, 1893	60.0	17.7	21.6	......	21.1	34.6	11.3	6.3
21065[1]	♀	Animas Valley (Colorado?)	Sept. 9, 1895?	89.8	22.3	28.8	96.6	31.8	49.5	12.1	7.2
2562[1]	♂	Red River, Arkansas	.. ..	88.5	25.0	31.5	113.1	33.6	54.4	14.5	8.1

[1] From collections of United States National Museum.
[2] In California unless otherwise stated.
[3] Tip of snout to posterior border of pubic symphysis.
[4] From pubic symphysis.
[5] Including tarsus.

LITERATURE CITED

Cope, E. D.

1889. The batrachia of North America. U. S. Nat. Mus., Bull., **34**, 525 pp., 86 pls., 119 figs. in text.

Say, T.

1823. *In* Long, Stephen H., Account of an expedition from Pittsburgh to the Rocky Mountains performed in the years 1819 and '20 by order of the Hon. J. C. Calhoun, Sec'y of War; under the command of Major Stephen H. Long from the notes of Major Long, Mr. T. Say, and other gentlemen of the exploring party. Compiled by Edwin James, botanist and geologist for the expedition. (Philadelphia), 2 vols. [+ atlas], 503 + 442.

Van Denburgh, J.

1905. The reptiles and amphibians of the islands of the Pacific Coast of North America from the Farallons to Cape San Lucas and the Revilla Gigedos. Proc. Calif. Acad. Sci. (3), 4, 1–40, pls. 1–7.

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REPORT UPON MAMMALS AND BIRDS FOUND IN PORTIONS OF TRINITY, SISKIYOU AND SHASTA COUNTIES, CALIFORNIA, WITH DESCRIPTION OF A NEW *DIPODOMYS*

BY

LOUISE KELLOGG

(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

The Trinity, Salmon and Scott mountains form a chain lying in an intermediate position between the Sierra Nevada and the Coast Ranges, on the east and west, respectively, and merging through the Siskiyou Mountains at the north into the Cascade Range. The river systems which drain this chain of mountains occupy valleys somewhat similar to those which furrow the western flank of the Sierra Nevada. The streams all flow ultimately in a westerly direction and finally meet the Klamath River, which forms their common outlet to the seacoast. There is thus offered an interesting problem in animal distribution; for the faunas of the Sierra Nevada to the east, the Coast belt to the west, and the Cascades

to the north, are decidedly different from one another. The fauna of the Trinity region could reasonably be expected to have resulted from an intermingling of forms from all three directions.

With a view to obtaining exact information pertaining to the fauna and flora of this region, embracing a part of northeastern Trinity County, southwestern Siskiyou County and a corner of northwestern Shasta County, Miss Annie M. Alexander organized and financed two trips, one in February and March, 1911, to Helena, Trinity County, and another during the summer months of the same year, over the wider territory indicated in detail in the following itinerary and on the map (fig. A, page 337). The specimens obtained, numbering 449 birds, and 976 mammals, have been presented by Miss Alexander to the California Museum of Vertebrate Zoology. The present report is based upon these specimens and is supplemented from the field notes of the collectors.

ITINERARY

SCHEDULE

Helena, Trinity County, February 11 to February 26, 1911.

Tower House, Shasta County, February 28 to March 8.

Mayten, Siskiyou County, June 3 to June 6.

Scott River, 6 miles northwest of Callahan, Siskiyou County, June 7 to June 14.

Jackson Lake, Siskiyou County, June 15 to June 27.

Wildcat Peak, Siskiyou County, June 27 to June 30.

North Fork of Coffee Creek, Trinity County, July 1 to July 9.

Saloon Creek Divide, Siskiyou County, July 9 to July 10.

South Fork of Salmon River, Siskiyou County, July 12 to July 17.

Summerville, Siskiyou County, July 17 to July 19.

Hunters' Camp, Trinity County, July 19 to July 20.

Head of Grizzly Creek, Trinity County, July 20 to July 25.

Head of Rush Creek, Siskiyou County, July 26 to August 2.

Kangaroo Creek, Siskiyou County, August 3 to August 5.

Head of Bear Creek, Trinity County, August 5 to August 17.

Castle Lake, Siskiyou County, August 18 to August 23.

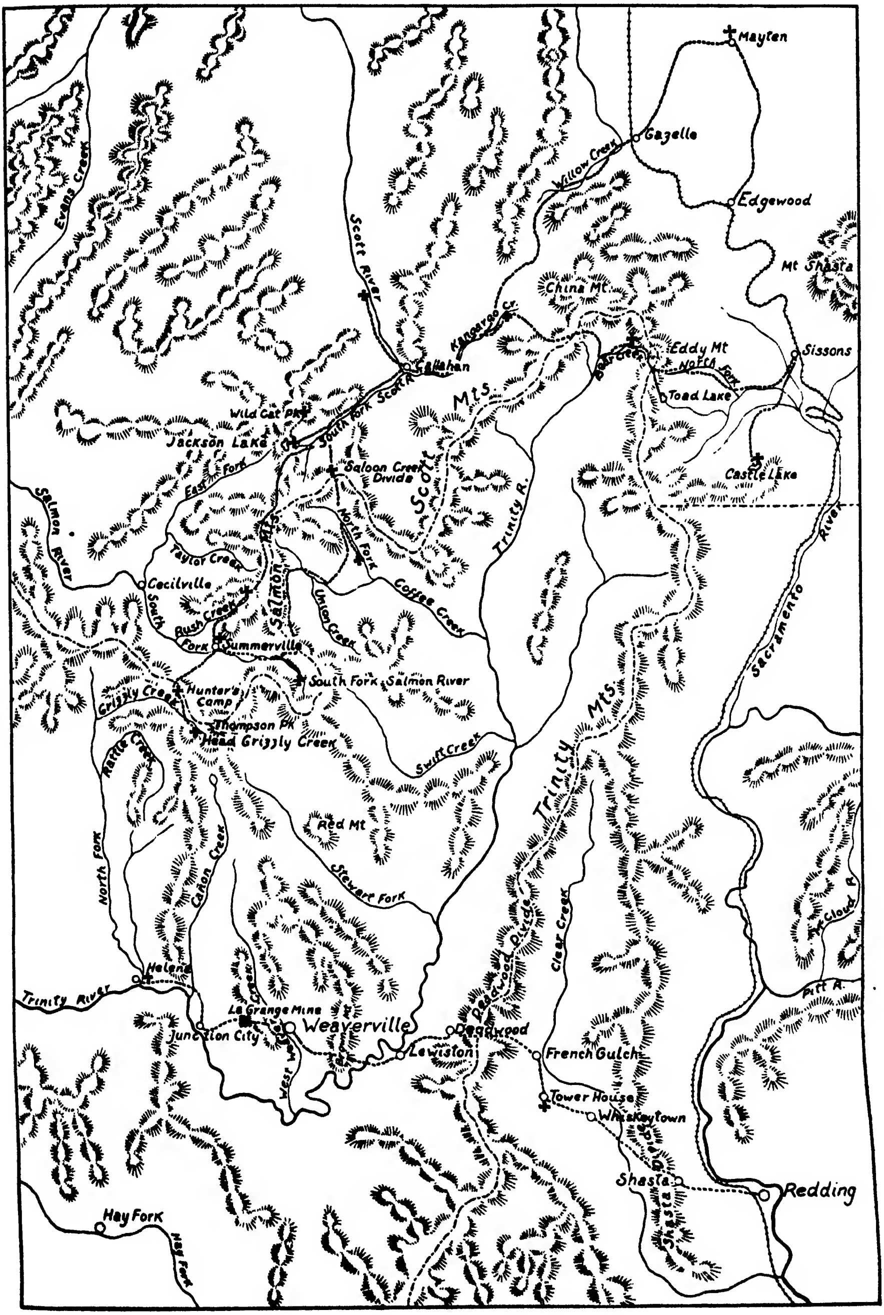


Fig. A. Map of portions of Siskiyou, Trinity and Shasta counties, showing routes (broken lines) traversed by Miss Annie M. Alexander and Miss Louise Kellogg in their zoological explorations of the region.

DESCRIPTION OF ROUTE

As a preliminary to the work of the summer, Miss Alexander and the writer spent a month, from February 10 to March 8, 1911, at Helena, on the North Fork of the Trinity River, in Trinity County, and at Tower House, in Shasta County.

We went by stage from Redding, Shasta County, following the Sacramento River for about three miles, then up Shasta Creek and over the Shasta divide, elevated 1800 feet above sea level, down into the valley of Clear Creek to Tower House and French Gulch, and from there over the Deadwood divide, 4550 feet by aneroid, to Lewiston, on the Trinity River.

The east slope of the Shasta divide presents a scene of desolation as a result of the killing of the trees by fumes from the smelters. On the west side the vegetation is more flourishing, but miles of timber and chaparral have been demolished by forest fires. When we crossed the Deadwood divide, February 9, there was much snow near the summit. We saw very few birds, only a flock of chickadees and kinglets, and a few quail. Mammals were even less in evidence, although in places we saw a few tracks in the snow near the road. Only one chipmunk and one gray squirrel were actually seen on the entire stage trip through to Weaverville.

We spent the night at Lewiston and went on the next day to Weaverville, following the Trinity River for about three miles, crossing it and climbing over the shoulder of Brown Mountain, and down into Weaverville, arriving there February 10. Consultation with some of the people of the town seemed to point to Helena, on the North Fork of the Trinity, as being a good place for trapping, and further desirable because George Knowles, considered to be one of the best trappers in the county, was staying there. It is an eighteen mile drive up West Weaver Creek, then over the Oregon Gulch Mountain, 1050 feet, and down the gulch to Junction City on the Trinity River. This Oregon Gulch is being filled up at the rapid rate of twelve feet a month by debris from the La Grange hydraulic mine. The water of the Trinity River itself is turbid from the many mines scattered along its course. From Junction City we turned up Cañon Creek for a short distance, then doubled back to the Trinity and followed it down to where the North Fork empties into the main stream. The water of North Fork was beautifully clear in contrast to that of the muddy main river, and its

narrow cañon leading up to a mass of snow-covered peaks gave one the impression of having entered a really wild and rugged country. Below North Fork, or Helena, as the small settlement is called, the Trinity River enters a deep rocky cañon.

HELENA is a postoffice town consisting of a hotel, store and couple of houses, situated at the junction of the Trinity River and its North Fork. The narrow cañon of the North Fork opens out enough to make a little farming possible; but the wooded hills rise close on every side, with higher mountains in sight just beyond. The principal trees and shrubs noted in the vicinity were: digger pine, Douglas fir, oaks, ceanothus and poison oak. This is considered a good trapping country for such fur-bearing mammals as fox, coon, skunk, civet cat, and, to a less extent, fisher. Larger mammals such as black-tailed deer, wild-cat and mountain lion were reported common. The life-zone at Helena is Upper Sonoran, with many Transition elements intruding from the closely surrounding area of pure Transition.

We spent two weeks collecting at Helena, and then returned by way of Weaverville back along the stage line as far as Tower House, where we stayed for ten days, returning then to Oakland March 9.

TOWER HOUSE is a hotel resort at the lower end of Clear Creek Valley, eighteen miles from Redding. A violent storm which raged during most of our stay kept us from seeing much of the surrounding country, but it appeared to be a place typical of the worked-out mining region so prevalent in Shasta County. The interests of the people center in the cultivation of small farms and in the cutting of wood. The tree stand is of digger pine and oak, and the chaparral consists of deer brush and manzanita. The zone may be considered Upper Sonoran.

We made our second start from Oakland on the evening of June 3, with John Howard as assistant. We left the train at Edgewood, Siskiyou County, and went by team to Mayten, twelve miles to the northward in Shasta Valley.

MAYTEN is perhaps better known by the name of Big Spring, which is more specifically applied to a wet meadow several acres in extent in the center of Shasta Valley. The spring itself forms one of the sources of the Shasta River. A dam at the head of the spring backs the water up, forming a small lake, along the edge

of which tules grow abundantly. The people told us that ducks occur here plentifully during the winter and that a few stragglers remain and nest. The water is used for irrigation, but the rocky nature of the soil in this part of the valley makes agriculture difficult. Bird and mammal life centers close around the spring and where the land is cultivated. We had hoped to obtain here, at the type locality, specimens of *Reithrodontomys megalotis klamathensis* and might have had better success if we had trapped in a hayfield. As it was, near the spring, we did not get any. One farmer reported kangaroo rats as being abundant in the upper part of the valley where the soil is better and farming is carried on to a greater extent, but we saw no sign of them ourselves. Sage-brush grows on the rocky, uncultivated ground, and the scattering trees are juniper and small yellow pine. The region is distinctly Upper Sonoran in zone. We stayed here only two days, and then went to Gazelle, a small town on the line of the railroad and the first station north from Edgewood. While staying there over the night of June 6 so as to get the stage to Callahan, we set a few gopher traps in an alfalfa field close to the town, securing specimens of *Thomomys leucodon navus.* Our observations were naturally limited, but indications pointed to the same zonal position as Mayten, namely Upper Sonoran.

We left Gazelle the morning of June 7 by stage for Callahan, twenty-five miles to the west and at the south end of Scott River Valley. We passed over a divide of about five thousand feet altitude and reached Callahan a little after noon. As the immediate vicinity of the town did not look favorable for collecting we drove about six miles down the valley and made camp on a small slough tributary to the Scott River. According to report there was still too much snow in the mountains for us to attempt to go up to a high altitude, so we put in the time from June 8 to 14 collecting at this camp.

SCOTT RIVER VALLEY is a fertile stretch some twenty-four miles long and varying in width from one to six miles. It is hemmed in on the east by low rocky hills covered with sage-brush and ceanothus, with a scattering growth of yellow pine and oak (see pl. 15, fig. 1). On the western side the hills are somewhat more rugged and heavily timbered, and numerous small streams make their way down narrow cañons into the main river. The town of Callahan

lies at the extreme southern point of the valley, where the river makes its entrance from a cañon about a mile wide and six miles long. Beyond this lies the main valley, but we did not go farther north than our camp, which was situated just where the valley begins to widen. The altitude is 3000 feet.

The water from the river is used extensively for irrigation. We were told that about fifty years ago the whole stream was diverted to the eastern side of the valley where it now runs, perhaps to facilitate in some way the use of the water. Our camp was situated in the old river-bed; the sandy bottom-land, undisturbed, has gradually become covered with a dense growth of cottonwoods and willows. Zonally the valley is mainly Upper Sonoran, but there are a number of Transition elements mixed in. Of particular interest was the discovery of *Dipodomys,* which finds here an ideal home in the sand of the river-bed. Birds, of the streamside category, were numerous.

As the weather had become very warm we decided to go up to Jackson Lake on the eastern slope of the Salmon Mountains. The move was made on June 15, and this may be considered our first base camp on the main line of the proposed fieldwork. We secured the services of Mr. John Baker as guide and hunter, with five pack animals to be used in transporting our outfit from camp to camp.

JACKSON LAKE is a nearly circular bit of water, at an altitude of 6000 feet, lying in an amphitheater of rocky peaks. The highest of these, situated on the north side of the lake, is called Wildcat Peak. The only break in the rocky wall is where Jackson Creek flows out from the lake to the east down a narrow valley, green with meadows and alder thickets. A thick stand of yellow pine, fir, spruce, hemlock, tamrac pine, and some sugar pine, fills in this open side of the lake and extends back up along the side of Wildcat Peak almost to its barren summit. On our arrival, June 15, there was still much snow around the lake, especially on the rugged south side, with a few patches in the woods. There is a small pebbly beach on the north side of the lake, but for the most part the rocks descend sheer into the water. Several small streams enter the lake on the south, east, and north. We had fortunately arrived early enough to avoid any running of cattle or sheep into the meadows, and as the timber around the lake has not been cut, it was

as natural and unsullied a collecting ground as one would wish to find. The variety of mammal life confirmed this idea thoroughly, for the locality yielded the greatest number of species of any of our camping places, with the exception of Helena. Birds were not numerous as to individuals except for chickadees and juncos.

Judging from the mammalian fauna and the trees the region is in the Canadian division of the Boreal zone. Among the mammals taken were: golden-mantled ground squirrel, flying squirrel, mountain beaver, bushy-tailed wood rat, red-backed mouse, mink and marten.

WILDCAT PEAK was visited as a side trip of three days, June 27 to 30. This is considered the highest point near the Lake, having an elevation of 7200 feet. We accomplished almost nothing in the collecting line while there, both because of the apparent scarcity of small mammals and birds and on account of a severe storm of rain and sleet. Our camp was about 300 feet below the summit, at the upper limit of the red fir growth. There were a few scattering firs above, and some white-barked pines; but the top of the ridge is very narrow and rocky, falling off abruptly to the north. From the summit one obtains a comprehensive view of the Scott and Salmon mountains to the south and west, and of Mount Shasta to the east. There was almost no life at this altitude; but the fact was due probably not so much to the height as to the barren, rocky nature of the ground. But five species of small mammals were taken, one an *Aplodontia* secured in a meadow below the peak on the north side. Birds were as scarce as mammals. The trees indicate that the peak rises barely into the Hudsonian zone.

Our next move, July 1, was to the North Fork of Coffee Creek, almost due south across Saloon Creek divide, 6850 feet, in Trinity County.

NORTH FORK OF COFFEE CREEK is a good-sized stream making its way precipitately down a narrow, well-wooded cañon. There are numerous small meadows where creeks make into the main stream, the banks of which are densely clothed with alders. The timber is mainly white fir, Douglas fir, yellow, sugar, and silver pine, cedar, and a few cottonwoods. This growth does not extend far above the creek bed on the north side, but gives way to a dense growth of deer oak and white-flowered ceanothus which was in full bloom. Our camp was at the junction of the North Fork of Coffee Creek with Granite Creek, at an elevation of 4500 feet, with only

1500 feet difference between it and Jackson Lake, but the difference in temperature and the character of the surroundings was very marked. Here we were in full summer, while there it was spring. Just above our camp was a deer lick well known to our guide, and he told great tales of the deer he had seen in that lick. The zone may be considered Transition, but this diagnosis was based more upon the vegetation than upon the animal life, for we found here several Boreal mammals which thus ranged well down into the Transition, *Zapus* for example.

SALOON CREEK DIVIDE.—On July 9, Miss Alexander and I made a trip back to Saloon Creek Divide, staying one night and putting in the afternoon and morning in collecting. This divide, of 6850 feet altitude, forms part of the line between Trinity and Siskiyou counties. On the northern, Siskiyou, side, which is almost devoid of trees, a descent of about 500 feet brings one to a small stream fed from the snow banks of the divide (see pl. 15, fig. 2). Here we had seen numerous holes of the golden-mantled ground squirrel, and it was to collect some of these that we made the trip up from the North Fork. The southern side is equally steep, but covered thickly with ceanothus brush. We camped on the north side in a grove of red fir and devoted our collecting to ground squirrels and chipmunks. This was the first time we had ever found such a colony of the former *(Callospermophilus)*. Their burrows were under every rock, as well as out in the open, and we could see many of the animals running about or sunning themselves on the rocks. We expected to find *Microtus* and *Zapus* in the alders along the stream, but the ground had been so beaten down by cattle that the smaller mammals had evidently not thriven.

After twelve days on the North Fork, we started out again, following up the creek and then striking across a 6100-foot divide and down gradually to the main Coffee Creek. We camped the night of July 11 about a mile above its junction with Union Creek. The next day we proceeded up the creek to the Salmon Flats, large mountain meadows which form a low divide between Trinity and Siskiyou counties. The ascent was a gradual one and the vegetation abundant at the divide itself. Cottonwoods attain an immense size in the moist creek bottomland, and willows form dense thickets on either side of the stream. From the divide we went up the South Fork of the Salmon River about two miles and camped in

a small grove of pines by the river, where we stayed from July 12 to 17. Here we found ourselves again in Siskiyou County.

SOUTH FORK OF THE SALMON RIVER heads in a semicircle of high peaks of about 7500 feet altitude. Our camp was at an altitude of 5000 feet, on the edge of a fine meadow of white clover interspersed here and there with large patches of false hellebore. Southwest of us, looming up across the river, was a high rocky peak with a good bit of snow on it, and beyond that was a sharp-pointed peak of solid rock with precipitous sides, probably about 8000 feet in height. There is no heavy timber on either side of the valley, but more on the east side than the west, where the mountains are rocky and covered mostly with chaparral. The trees around us were yellow, sugar, and tamrac pine, white fir, and Douglas fir. The banks of the river were brushy with alders and willows. We had evidently again reached the Canadian zone, and a few new birds were added to the inevitable juncos and chickadees in the way of kinglets, both ruby-crowned and golden-crowned, Lincoln sparrows, and creepers.

SUMMERVILLE, eleven miles down the river, was our next objective point. This is the name given to a series of mines and farms along the main Salmon River, 2000 feet below our last camp. The change from firs and tamrac pines to oak, manzanita and scattered madrone was very marked. The country looked dry and unattractive after the higher mountain region; but the land can be made to produce well under irrigation, as we saw on the farm of Mr. Jack Hinz at whose place we stopped. His land lies on a bench some distance above the river, back of which rise the hills, while between them and the stream stretches a strip of glaring rock and sand, the remains of former hydraulic mining. Across the river the mountains rise steeply to a height of 5600 feet, covered below with black oak, madrone, Douglas fir and sugar pine, and higher up with a chaparral of chinquapin, white ceanothus and manzanita, which runs to the top of the ridge. The zone at Summerville may be considered high Upper Sonoran, with close investment on all sides by Transition.

At Summerville we added to our party Mr. Jack Hinz, at whose ranch we camped for a night, and who proved familiar enough with the country to be able to follow up an old government trail leading to the head of Grizzly Creek. Here we would be within reach of the highest peak in the Salmon Mountains. It took us two

days from Summerville to reach the head of Grizzly Creek, the night of July 19 being spent at Hunters' Camp.

HUNTERS' CAMP, used by hunters and cattle men, is situated about a hundred feet down on the southern slope of the divide between Salmon River and Grizzly Creek, in a grove of white fir. The slope down to Grizzly Creek is very steep and the underbrush of chinquapin and ceanothus dense. There is a good spring coming out just below the camp, and its downward course is marked by dense alder clumps. Mr. Hinz says he often comes up on this ridge during the winter to trap, and has caught several fisher here.

The trail up Grizzly Creek from Hunter's Camp had been blazed years ago by a government surveying party which had made the ascent of a peak next to that known as Thompson Peak, and considered the highest point of the Salmon Range. We were unable to ascertain the name of this peak from any of the people in the region, and it is not given on the maps, but is so close to Thompson Peak and so nearly of the same height that for the sake of convenience it also may be called Thompson Peak.

GRIZZLY CREEK has as its source a fair-sized lake lying in a rocky bowl between the mountains, and fed by great snow banks. The outlet of the lake is a waterfall which makes a sheer leap of about fifty feet over a rocky wall, and then by a succession of smaller drops descends into Grizzly Cañon. Our camp was just at the base of this precipice in a clump of red fir, white pine, and hemlock, flanked by large open meadows and willow thickets.

In scenic beauty this spot surpassed any of our other camping places (see pl. 17, fig. 5), but collecting was rather arduous on account of the ruggedness of the ground and the steep slopes, either up or down; for the cañon is hemmed in on all sides, except in the direction of its outlet, by rocky walls. Small mammals were not particularly abundant, and Mr. Hinz attributed the lack of marten and fisher sign to the absence this year of suitable food, especially chipmunks. *Aplodontia* sign was abundant in a small cañon where a stream and alders provided their favorite habitat (see pl. 16, fig. 3), and *Zapus* and flying squirrels were secured. One deer was shot high up on the crest of the mountain a thousand feet above camp. Save for elusive thrushes which sang in the underbrush, birds were rather scarce right around our camp. The density of the tree growth probably accounted for this. In the

more open places and meadows the birds were about as plentiful as at other camps. This locality is in the Canadian zone.

Our aneroid registered 7900 feet at the top of Thompson Peak, which is a pointed mass of rock dropping off steeply on all sides and surmounted by a government monument. Except for the last hundred feet or so up this point, the ascent of the mountain was not difficult, mainly over great stretches of granite rock and snow slides until we reached a granite ridge which forms the main approach to the peak. About half way up we obtained a good view of the lake which is the source of Grizzly Creek. There was ice still in it and we were told that the snow bank between the two peaks, from which it is fed, never entirely melts. On the eastern slope of the ridge were wind-blown specimens of white-bark and foxtail pines forming a heavy growth, while on the western slope tongues of hemlock ran up the mountain sides.

The view from the summit well repaid us for the climb. On the east was Mount Shasta; directly below us to the south, two small lakes which constitute the source of the Stewart Fork of the Trinity River. Rattlesnake Creek also heads off to the south, separated from Stewart Fork by a jagged crest of rocks. The watershed of the Rattlesnake is fan-shaped, the granite smooth as if planed by glaciers, but covered with a scattering growth of pines and hemlocks. To the south and west we saw the Trinity Mountains and the Coast range; in fact, as far as the eye could reach, there were mountains. We were told that Mount Hood can be seen from here on a clear day, but this sounds like an exaggeration. We collected specimens of red and white heather and other plants of the Hudsonian zone.

We put in four days collecting on Grizzly Creek and then returned to Summerville. Another night, that of July 25, at Hinz's ranch and we were off up Rush Creek to its head, where we camped in a large meadow.

RUSH CREEK heads in broad, open meadows with occasional strips of alders (see pl. 17, fig. 6). Patches of red fir skirt the outer edges of the meadows and extend up to the divide, which rises on either side of the lowest point of the saddle. Our camp was at an altitude of 6400 feet, with the divide some thousand feet higher. The outlook to the south and west was quite comprehensive and we could see directly across to the two Thompson Peaks with the snow bank between. A side cañon to the south of our camp con-

tained a small lake surrounded by trees and proved a favorite haunt of birds. The meadow was variegated with flowers, hellebore, painted cup, and larkspur. The cattlemen say that larkspur and wild parsley are fatal to cattle and they never keep their stock more than one night in this region. They claim horses are not affected. Flying squirrels were abundant and easily trapped in the higher groves of red fir, and we also secured several marten here. Mr. Baker shot a magnificent buck on a high ridge to the south. *Zapus* lived among the alders along the stream. The Lincoln sparrow was nesting here in a clump of hellebore. The zone may be therefore considered Canadian.

On August 2 we made a forced march back to Callahan, over the Rush Creek Divide, around the heads of Taylor Creek and one of the branches of Coffee Creek, down into the East Fork of the Salmon River, up again until we struck the Scott River watershed, and thence down into Callahan.

KANGAROO CREEK, a tributary of Scott River, then became our base of operations. Our camp here was situated at some deserted mining cabins about eight miles northeast from Callahan and several hundred feet higher, at an altitude of 3300 feet. We were disappointed to find that hydraulic mining had been carried on in the creek, thus spoiling all the natural aspect of the place. Also there was almost no water except from a small spring near the buildings, so that any hope of finding many small mammals was vain. The side-hills were dry and unattractive, and birds consequently scarce.

The thing of chief interest about the place was the mixture of zones, for we here found round-tailed wood rats and bushy-tailed ones inhabiting the same cabins. Also there were golden-mantled ground squirrels, which, with the bushy-tailed wood rats, must have been at the lowest line of their distribution. The place being shut in, as it is, in the cañon, is probably somewhat colder in winter than at Callahan, although there is so little difference in altitude and general conditions; this, combined with heavier timber, may account for the presence of the two high-zone mammals named. The tree stand is chiefly yellow pine. The locality may be considered prevailingly Transition.

The collecting at Kangaroo Creek was so disappointing that after two days' work we were glad to start for Bear Creek, one of the northern tributaries of the Trinity River, and at the base of

Mount Eddy. Here we remained from August 5 to 17, and, besides making the ascent of Mount Eddy, we spent a day at Toad Lake, one of the sources of the Sacramento River.

Bear Creek is the second tributary from the head of Trinity River. We camped almost at its head, altitude about 6000 feet, in an attractive meadow, dotted with clumps of tamrac pine, alder, and willow, and supporting a heavy growth of grass and rank hellebore. Several acres had been fenced in by the forest rangers so that they could have a place in which to pasture their horses, that had not been trampled by the hordes of cattle. The trail from Kangaroo Creek, for the most part through sparsely wooded hills and open rocky stretches, had not prepared our minds for anything so green and inviting as this stopping-place proved to be, so we were very agreeably disappointed in it, and found the collecting excellent.

The side-hills were covered with a growth of deer-oak and manzanita, white, and red fir, cedar, and yellow pine. Of the cedar there were some especially fine old trees. There was an abundance of water coming down in small streams on both sides of the main creek, and that element always makes for plentiful bird and mammal life. The list of mammals included the golden-mantled ground squirrel, two species of chipmunks, flying squirrel, snowshoe rabbit, *Zapus,* and marten. Birds were plentiful, both near camp and in the woods, among them being Lincoln sparrow, Lewis woodpecker, ruby-crowned kinglet, and creeper. The locality may be considered as prevalently Canadian in zone.

Mount Eddy is a bare, cone-shaped peak, 9151 feet in elevation, next to Shasta the highest point in the region. But, because of the lack of snow and its ruggedness, it does not give one the impression of great height. We made the ascent August 14 by way of Deadfall Cañon and experienced no hard climbing at all, but found it undesirable to stay long on the summit on account of the violent wind that was blowing. The southwest side of the peak is well timbered with foxtail pine, and a few straggling white-bark pines reach almost to the barren summit, which is covered with loose shale rock. There was a small bank of snow on the north side. We got a good view of the Salmon Mountains, and counted eight ridges between us and Lassen Butte. Mount Shasta looked stupendous, but the view toward the Sacramento Valley was unsatisfactory on account of the haze. We saw some nutcrackers and vireos near a small lake about 500 feet below the summit, and

almost at the top I heard a chipmunk. We collected a number of botanical specimens, mostly species of the Canadian and Hudsonian zones.

We spent August 12 at Toad Lake, Siskiyou County, which is across the divide, south, from Bear Creek. In making the ascent to the divide we passed through a forest of young silver pine, and on the summit saw a much-branched white-bark pine. The lake is circular, several acres in extent, and has an underground outlet which is the source of one of the western branches of the Sacramento River. On the eastern side is a tundra-like marsh with tamrac pines growing along the edge. Other trees around the lake are silver pine, red and white fir, Jeffrey pine, and hemlock. The south wall of the basin has no timber and is very rocky.

CASTLE LAKE.—On August 17 we left Bear Creek and, after crossing the divide at its head, followed the North Fork of the Sacramento in to Sisson. John Baker left us here, and the next day we secured a wagon and went to Castle Lake, a favorite summer camping place for the people of Sisson. This lake lies at an altitude of 5434 feet, about twelve miles southwest of Sisson. There are a few trees left in their natural state around the lake and for a mile or so down the cañon from it, but over all the rest of the country between it and Sisson the timber either has been cut or is in process of being cut, and I believe this in part accounts for the strange mixture of life-zones that we found there. The eastern slope of the lake is sparsely wooded with white fir, and tamrac, yellow and silver pine, trees belonging to the Canadian zone, while the western side is a brushy hill covered with chaparral of plum, currant, ceanothus, manzanita, and spiraea. The south side is a wall of granite and broken rock slides, precipitous and forbidding. It was on these rock slides that we caught a bushy-tailed wood rat, and a dark bit of fir woods produced a flying squirrel. Golden-mantled ground squirrels lived on the dry side-hill, and the common ground squirrel of the lowlands *(Citellus douglasii)* was taken where the creek leaves the lake. Two unusual forms also taken here were *Evotomys* and the least weasel.

Considered from the zonal point of view this seemed about the strangest association of mammals that one could encounter. It is probable that in altitude and original state the locality belonged to the Canadian zone. The cutting of the timber raised the temperature and lessened the fall of rain and snow so that animals

of the Transition zone gradually worked up from the valley; and yet the higher zone forms are not yet altogether crowded out. It is only a question of time, it would seem, before the locality will become more purely Transition. At any rate, Castle Lake proved an interesting collecting point and made a good finish for our trip, which terminated at Sisson on August 23.

CHECK LIST OF THE MAMMALS

1. Scapanus latimanus latimanus (Bachman).
2. Neurotrichus gibbsi major Merriam.
3. Sorex vagrans amoenus (Merriam).
4. Sorex montereyensis montereyensis Merriam.
5. Myotis longicrus longicrus (True).
6. Lasionycteris noctivagans (LeConte).
7. Eptesicus fuscus fuscus (Beauvois).
8. Ursus americanus Pallas.
9. Canis lestes Merriam.
10. Urocyon cinereoargenteus townsendi Merriam.
11. Bassariscus astutus raptor (Baird).
12. Procyon psora pacifica Merriam.
13. Martes caurina caurina (Merriam).
14. Martes pennanti pacifica (Rhoads).
15. Mustela muricus (Bangs).
16. Mustela saturata (Merriam).
17. Mustela vison energumenos (Bangs).
18. Spilogale phenax phenax Merriam.
19. Mephitis occidentalis occidentalis Baird.
20. Felis oregonensis oregonensis Rafinesque.
21. Lynx fasciatus Rafinesque.
22. Reithrodontomys megalotis klamathensis Merriam.
23. Peromyscus maniculatus gambelii (Baird).
24. Peromyscus boylii boylii (Baird).
25. Peromyscus truei gilberti (Allen).
26. Neotoma fuscipes fuscipes Baird.
27. Neotoma cinerea occidentalis Baird.
28. Evotomys obscurus Merriam.
29. Microtus montanus montanus (Peale).
30. Microtus californicus californicus (Peale).
31. Microtus mordax mordax (Merriam).
32. Thomomys leucodon navus Merriam.
33. Thomomys monticola pinetorum Merriam.
34. Dipodomys californicus trinitatis, subsp. nov.
35. Zapus trinotatus alleni Elliot.
36. Aplodontia chryseola Kellogg.
37. Citellus douglasii (Richardson).
38. Eutamias amoenus amoenus (Allen).
39. Eutamias senex (Allen).

40. Callospermophilus chrysodeirus trinitatis Merriam.
41. Sciurus douglasii albolimbatus Allen.
42. Sciurus griseus griseus Ord.
43. Glaucomys sabrinus flaviventris Howell.
44. Lepus washingtonii klamathensis Merriam.
45. Lepus californicus californicus Gray.
46. Sylvilagus bachmani ubericolor (Miller).
47. Odocoileus columbianus columbianus (Richardson).

GENERAL ACCOUNTS OF THE MAMMALS

Scapanus latimanus latimanus (Bachman)

Central California Mole

One skull (no. 12996) was picked up at Tower House, and one skin-with-skull (no. 13798) was secured at Scott River. The latter, a male, measures as follows: total length, 165 millimeters; tail vertebrae, 35; hind foot, 21.

Neurotrichus gibbsi major Merriam

Large Shrew-Mole

The two specimens (nos. 12908, 12909), which we obtained at Tower House are placed under this subspecies since both in measurements and in the presence of an anterior cusp on the cingulum of the upper premolar they correspond to the description (Merriam, 1899, p. 88). There is considerable difference in elevation between the type locality of *N. g. major*, Carberry Ranch, Shasta County, altitude 4100 feet, and Tower House, altitude 1200 feet. The former locality is in the upper part of the Transition zone, the latter in high Upper Sonoran.

Sorex vagrans amoenus (Merriam)

Sierra Nevada Shrew

Shrews were not common at any of the points where we collected. A series of sixteen of this form was secured (nos. 13780-13795), seven of them taken at Mayten, Siskiyou County, our lowest camp. Other localities where they were found are: Castle Lake, Siskiyou County, two; Salmon River, Siskiyou County, three; Rush

Creek, Siskiyou County, three; and Bear Creek, Trinity County, one.

Average measurements of seven specimens from Mayten are as follows: total length, 98.8 millimeters; tail vertebrae, 38.4; hind foot, 12. Average of nine from other localities: total length, 98.5; tail vertebrae, 38.4; hind foot, 12.3.

Sorex montereyensis montereyensis Merriam

Monterey Shrew

Four specimens of this shrew were taken, three at Tower House, Shasta County (nos. 12906, 12907, 12997), one at Castle Lake, Siskiyou County (no. 13797), and one at Jackson Lake, Siskiyou County (no. 13796). Average measurements of four of these: total length, 112 millimeters; tail vertebrae, 48.7; hind foot, 13.

Myotis longicrus longicrus (True)

Long-legged Bat

There is nothing quite so wasteful of ammunition as shooting at bats. At Kangaroo Creek and Castle Lake we used to spend the evenings until dark trying to hit the wavering, fluttering things. The time for shooting was limited because the bats would not come out until the light was nearly gone; this accounts in part for the few secured. Two specimens of the above species (nos. 13804, 13805) were taken at Castle Lake, August 22.

Lasionycteris noctivagans (Le Conte)

Silver-haired Bat

Two specimens were gotten at Kangaroo Creek, August 4 (nos. 13802, 13803); these are evidently young, though they were well able to fly.

Eptesicus fuscus fuscus (Beauvois)

Large Brown Bat

Two specimens taken at Kangaroo Creek, August 3 and 4 (nos. 13799, 13800), and one at Castle Lake, August 19 (no. 13801).

Ursus americanus Pallas

Black Bear

The region around Callahan, Siskiyou County, and from there westward through the mountains as far as we went, is one in which, according to common report, black bears are still fairly numerous. At Callahan we were told how men went out with dogs in the winter and without having gone any great distance would return bringing a bear. We saw some good-sized skins for sale there, and Miss Alexander purchased two (nos. 13765, 13766) in good winter pelage, but without skulls.

At Jackson Lake we saw some old sign; but it was not until Hunters' Camp was reached, on our way up Grizzly Creek, that we were told we were in the heart of the bear country. It certainly began to look like it, when John Howard took his rifle and within a few minutes walk of camp saw a bear ambling along among the trees. It had not scented him, so was going leisurely and he had a good shot. The bear was left all night where it fell, with a coat thrown over it; for, according to the hunters, coyotes will not touch anything which has any article of clothing left around it. This bear, a female, was not a large individual, possibly two years old. It was saved as skin and complete skeleton (no. 13764).

Subsequently, a skin and complete skeleton (no. 14712) taken near Callahan, October 7, 1911, was sent to the Museum by J. Baker.

Canis lestes Merriam

Mountain Coyote

When we were at Helena, George Knowles reported seeing many tracks of coyotes, but he did not secure any specimens. However, he later sent in a skin and skull (no. 12876) from Hay Fork. There is evidence that the two do not belong to the same animal, since the skull showed considerable weathering, while the skin was fresh. At any rate, the same locality is doubtless represented.

The skin shows no significant characters in either size or coloration; measurements (by collector): total length, 1040 millimeters; tail vertebrae, 305; hind foot, 178; height of ear, 89. The skull, however, differs somewhat from typical *Canis lestes*, and if more material were available to bear out the points, it would appear that we had at last found indications of a northwest-coast race of coyote.

Compared with a skull of *Canis lestes*, this skull shows only a very slight development of the deuterocone on P^4, the teeth are extremely massive and more crowded and the auditory bullae are larger and more inflated. Such characters would constitute good ground for specific differentiation if found repeated in several specimens.

During the summer we secured only one coyote, too young to be of any value for comparison (no. 13763). Our guide, Mr. Baker, saw fresh tracks on our trip up Wildcat Peak, at Jackson Lake, and confidently set some steel traps, baited with grouse, but he caught nothing. For the most part we were not in country where we should expect to find them, it being too high and mountainous. During our stay at Helena, Knowles reported seeing many coyote tracks and said that they bothered him by digging out and springing his steel traps set for other animals.

Urocyon cinereoargenteus townsendi Merriam

Townsend Gray Fox

At Helena foxes seemed to be abundant. Knowles secured seven in all (nos. 12879-12885), by trapping. The weights of these varied from 4½ to 10½ pounds. We bought two skins, without skulls, from D. M. Corliss at French Gulch, Shasta County (nos. 12877, 12878). In the Trinity and Salmon mountains we saw no sign of foxes.

In the series obtained, and which are otherwise referable to this form, the white stripe on the hind leg is quite well defined, although Merriam, in his description of *townsendi* (1899, p. 103), says: "The white stripe on the hind foot of *californicus* has disappeared and is represented by a pale streak."

Bassariscus astutus raptor (Baird)

California Ring-tailed Cat

All four specimens (nos. 12886-12889) of this species were taken at Helena, Trinity County. We might have found them at Tower House, too, but the weather while we were there was stormy and we did not devote much time to the setting of steel traps. George Knowles trapped three of the civet cats, and Miss Alexander and I, after a good deal of maneuvering, managed to trap one. We had

seen the tracks of a small animal in the sand along the river and, by taking an imprint of the foot of one of Knowles' specimens as a pattern, had decided they pertained to a civet cat. We set a number 1 steel trap under a willow tree, hanging the bait from a branch. The first night the animal climbed the tree, got out on the branch and dragged the bait over a side branch toward it. The second night we hung the bait farther out and nearer the ground, and cut off the side branches. The additional effort proved successful.

The largest specimen taken by Knowles (male, no. 12889) measured: total length, 720 millimeters; tail vertebrae, 340; hind foot, 70; ear, 45. Its weight was two pounds.

Procyon psora pacifica Merriam

Pacific Coon

Our specimens (nos. 12890-12894), three from Helena, one from Hay Fork and one from Tower House, all belong to this dark form of *Procyon* (see Merriam, 1899, p. 107). The saying "cunning as a coon" was exemplified in the case of one we finally trapped at Helena; but it was perhaps more because of our way of fixing the trap than of much cunning on the part of the animal that he was able to take our bait two nights in succession. We were trying a trap called "Stop-thief", which is supposed to catch the animal around the head, this being more humane than the common steel trap; but on account of its mechanism the animal had to step through it, so we arranged a cave of rocks with the bait inside and the trap at the entrance. The first morning after setting we found the remains of the bait, a saw-bill duck, about two yards away from the cave with the trap attached. It had been dragged through the entrance. The next morning the coon had torn the cave open from the opposite side. So we gave up the "Stop-thief", and readily caught the coon the following night in an ordinary steel trap, with suspended bait.

We saw no signs of coons in the higher mountains of the Salmon and Trinity ranges. Neither were any tracks seen at Scott River.

Martes caurina caurina (Merriam)

Northwestern Pine Marten

We secured seven specimens of marten (nos. 13767-13773), one at Jackson Lake, three at the head of Rush Creek, and three at the

head of Bear Creek. I have designated them as *Martes caurina,* although they are not typical of that form as represented by specimens in the Museum collection from Vancouver Island, British Columbia. Our specimens show both summer and winter pelages and in both instances the markings of the throat and under surface are not an orange red, as in the Vancouver specimens, but more of a yellow, and the whole body color is much paler. They also differ from the Vancouver specimens in having the metaconid of the lower carnassial more distinct. A female taken at Crescent City is described by Merriam (1890, p. 27) as being of a uniform light seal brown with yellowish markings. It thus appears that that individual together with our specimens represents an extreme southern type of *Martes caurina.*

Our no. 13772, male, in fresh fall pelage, has the center of the back raw umber shading to tawny olive on the sides; underfur wood brown. The underparts are tawny olive sprinkled with white hairs; markings of the throat, deep chrome. The ears are drab with a whitish edge; the nose vandyke brown. The front feet shade from Prouts brown to bistre. The tail is darker than the back; the brush seal brown. In another specimen, with worn pelage, the underfur of the back shows in patches vandyke and wood brown, and the throat markings have faded to maize yellow.

Our first specimen was taken at Jackson Lake at the foot of a rock slide on the east side of the lake. It was caught only by the side pad of one front foot, but so securely that the trap held in spite of the fact that the animal had gotten down below the rock where the trap was set and had crawled into a hole. At Rush Creek we caught one in a trap set under a big log in a dense grove of firs on the sidehill near a small stream, and the other two, evidently a pair, close together, out of six traps we had set up the cañon of a small stream leading into a lake. Here also the timber was dense. At Bear Creek we found martens in much the same situation among the timber and near water and I had the pleasure of seeing one running along a log, but he saw me first and his disappearance was rapid.

Martes pennanti pacifica (Rhoads)

Pacific Fisher

Knowles reported one day at Helena that a fisher had been around to all his traps, which were set on a ridge, and eaten the

bait. He had to dig the traps out of the snow, which had fallen since his previous round, and set them again, confident that he would catch the fisher; and he succeeded. He told us this specimen (no. 12901) showed a somewhat lighter tone of coloration than he had seen in other individuals. Before leaving Helena, Miss Alexander purchased a fisher skin (no. 12902) which had been taken about six miles from Helena in 1910.

Our next information in regard to the presence of fisher came from Jack Hinz at Summerville, Siskiyou County, on the Salmon River. He said he had often trapped them on ridges near his place. The night that we spent on the divide between the Salmon River and Grizzly Creek, at Hunters' Camp, Hinz set some traps for fisher, but his efforts here, and afterwards at the head of Grizzly Creek, were unsuccessful. He stated that the animals were much more difficult to catch in summer than in winter. The Museum collection has since then been enriched by four more specimens (nos. 16386, 16531, 16596, 19095), taken by Hinz near Cecilville, December 13, 1911, February 19, 1912, March 25, 1912, and January 27, 1913, respectively.

Description of the winter pelage follows: Above, from between ears to middle of back, buffy yellow shaded with black; an irregular black streak from middle of back to base of tail; sides cinnamon; general effect of tail black with background of vandyke brown; nose to eyes seal brown; underfur of head and neck vandyke brown, of back, hair brown; head grizzled with grayish white; throat blackish seal brown, darker on breast and belly; legs and feet black. In worn pelage: Above yellowish white to middle of back; black stripe more restricted; sides tawny olive; underparts lighter.

MEASUREMENTS IN MILLIMETERS OF *Martes pennanti pacifica* FROM NORTHERN CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Hind foot	Ear
12901	♀	Helena, Trinity Co.	830	340	90	35
16386	♀	Cecilville, Siskiyou Co.	864	375	88.5	50.5
16531	♂	Cecilville, Siskiyou Co.	997	381	114	50.5
16596	♂	Cecilville, Siskiyou Co.	991	368.5	120.5	50.5
19095	♀	Cecilville, Siskiyou Co.	864	349.5	101.5	38

Mustela muricus (Bangs)

Sierra Least Weasel

Of this tiny and apparently little known weasel we secured two specimens (nos. 13776, 13777), one at the head of Rush Creek, Siskiyou County, at an altitude of 6400 feet, and the other at Castle Lake, Siskiyou County, altitude 5434 feet. The first one was caught in a number 1 steel trap set under a log on the margin of a small lake. The one at Castle Lake came to oatmeal bait on a rat-trap set in a clump of firs where we were trapping for flying squirrels.

The two specimens agree with the description of *muricus* by Bangs (1899, p. 71) except for the tail of one, which is nearly all white but with the tip dark and with the upper basal half of the same color as the back. As this specimen also shows spots of white on the nose, behind the ears and on the upper flanks, it may be inferred that the species turns white in winter and that this individual had not fully completed its summer molt. The date of capture, July 28, however, is late for retention of even remnants of the winter pelage. The second specimen was taken August 20; close scrutiny of this one discloses a few white hairs in the tail, and two or three in the back.

The measurements of the two specimens are as follows: No. 13776, ♀, total length, 210 millimeters; tail vertebrae, 55; hind foot, 27; no. 13777, ♀, total length, 205; tail vertebrae, 51; hind foot, 27.

Mustela saturata (Merriam)

Siskiyou Weasel

Two specimens taken at Jackson Lake (nos. 13778, 13779) have been referred to this species, although as far as known this is the first record of its occurrence south of the type locality, Siskiyou, Oregon. There are no white facial markings. At the corner of the mouth is a distinct brown spot considered as characteristic of the species, and in general coloration the specimens otherwise correspond with the first published description (Merriam, 1896, pp. 21-22).

Measurements of the specimens, both male, are as follows: No. 13778, total length, 412 millimeters; tail vertebrae, 136; hind foot, 50; no. 13779, total length, 403; tail vertebrae, 150; hind foot, 43. These average smaller than the two males from the Siskiyou Moun-

tains, Oregon, the average measurements of which as given by Merriam are: total length, 423; tail vertebrae, 164; hind foot, 48.

Mustela vison energumenos (Bangs)

Pacific Mink

Two specimens were taken by us, one at Jackson Lake, Siskiyou County (no. 13774), and one on Coffee Creek, Trinity County (no. 13775), while three (nos. 12903-12905) were sent in later from Hay Fork, Trinity County, by George Knowles. The one secured at Jackson Lake was a female in extremely poor condition, thin, blind in one eye, and with an abnormal growth in the intestinal tract. The female caught on Coffee Creek, July 4, had borne young ones recently. Both of our specimens are darker than the ones from Hay Fork; the latter show a better defined mid-dorsal stripe. But the worn pelage of the two females precludes any accurate comparison of their coloration with that of other material at hand.

Spilogale phenax phenax Merriam

California Spotted Skunk

One specimen of this small skunk was taken at Helena (no. 12900). The teeth are much worn and the lower canines look somewhat deformed. The inner cusp of the upper carnassial is almost lacking. On geographical grounds we might expect to find *Spilogale phenax latifrons* here; but the less prominent black areas of the specimen place it under *phenax* proper.

Mephitis occidentalis occidentalis Baird

Northern California Striped Skunk

Three specimens (nos. 12895-12897) were secured while we were at Helena and two sent in later by George Knowles from Hay Fork (nos. 12898, 12899). The specimens average small in measurements, especially of the hind foot; only one approaches the measurement of the type in that regard, but the discrepancy may possibly be due to the method of measuring, so I have placed them without question under the above name.

Felis oregonensis oregonensis Rafinesque

Northwestern Cougar

One specimen (skin and skull, no. 12871) of mountain lion was gotten by George Knowles at Hay Fork, Trinity County, and sent in after our return.

Lynx fasciatus Rafinesque

Barred Wildcat

As the status of the various species of *Lynx* seems to be rather uncertain I have referred our specimens (four from Helena and Tower House, nos. 12872-12875) to the species first described. They certainly belong to the *fasciatus* group, if that name is to be applied to the more northern form of *Lynx,* rather than to the lighter-colored *californicus* from the south; but they are not as dark as some specimens in the Museum collection from Humboldt Bay. As no specimens of *Lynx fasciatus pallescens* are available for comparison I would hardly venture to identify ours with that form, even though Merriam (1899, p. 104) refers specimens taken on Mount Shasta to it. An adult male taken at Helena weighed nineteen pounds.

Reithrodontomys megalotis klamathensis Merriam

Klamath Harvest Mouse

It was not our good fortune to secure the harvest mouse from Mayten, the type locality. Our camp there was rather unfortunately situated in a dry rocky pasture and we were not conveniently near to the hayfields where we might have found the species. But three specimens from Scott River (nos. 13360-13362), and five from Tower House (nos. 12788-12792) have been referred to this form because of skull characters. The large skull, heavy rostrum, wider brain-case and relatively smaller bullae serve to distinguish our specimens from *R. m. longicaudus.* But the coloration is practically as dark as in *longicaudus,* so that our specimens might best be considered intermediate, and nearest *klamathensis.* The hind foot of four male specimens averages but 17 millimeters, as against an average of 18.5 for two adults from the type locality of *klamathensis,* as given by Merriam (1899, p. 93). One male (no. 12788) measures: total length, 147 millimeters; tail vertebrae, 77; hind foot, 18;

ear, 11.5; but this is no older, as shown by the teeth, than some of the smaller ones.

NOTE: Since the above was written, Howell's *Revision of the American Harvest Mice* (1914) has appeared, in which the name *klamathensis* is put into the synonymy of *longicaudus*. This ruling does not seem to properly dispose of the case, for the Museum of Verebrate Zoology contains material which points strongly towards the existence of a distinguishable race in northeastern California. This form does not appear to be merely an intermediate stage between *longicaudus* and *megalotis*, as Howell asserts. The cranial characters, as above specified, are too prominent to ignore, and, in combination with color, seem to be of diagnostic value.

Peromyscus maniculatus gambelii (Baird)

Gambel White-footed Mouse.

This white-footed mouse was in evidence at all the camps visited during the summer, and was also taken at Helena. A series of forty-one in all was secured (nos. 12745-12759, 13334-13359), representing the following localities: Helena, Tower House, Mayten, Scott River six miles northwest of Callahan, Jackson Lake, Wildcat Peak, north fork Coffee Creek, Saloon Creek divide, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, Castle Lake. The specimens are variously intermediate in characters between *P. m. gambelii* and *P. m. rubidus*, averaging a trifle nearer the former.

Peromyscus boylii boylii (Baird)

Boyle White-footed Mouse

Taken only at Helena and Tower House (nos. 12760-12779), and not found at any of the summer camps, although it was to have been expected at the localities of low altitude.

Peromyscus truei gilberti (Allen)

Gilbert White-footed Mouse

With the exception of one specimen from Mayten, Siskiyou County (no. 13333), this mouse also is represented only from Helena and Tower House, where eight specimens were secured (nos. 12780-12787).

Neotoma fuscipes fuscipes Baird

Dusky-footed Wood Rat

Most of our specimens of this animal came from Helena and Tower House, although the species was found to occur also at Scott

River and Kangaroo Creek. Most of our summer camps were evidently above the level of their range. Nineteen specimens (nos. 12812-12822, 13383-13390) were secured at the four localities named above.

Neotoma cinerea occidentalis Baird

Western Bushy-tailed Wood Rat

The bushy-tailed wood rat was not common at any of our camps, except that on the North Fork of Coffee Creek. Here Miss Alexander found a colony in a deserted cabin and specimens were trapped without any particular difficulty. At Jackson Lake where we found them first we looked for fresh sign in the rock slides at the south and west sides of the lake without success; but there was plenty of old sign, and rat-traps baited with bacon produced seven in all. The altitude at Coffee Creek was rather low for the species, as was also that at Kangaroo Creek, near Scott River. At the latter place, however, we again found them inhabiting an old cabin and this time in company with their round-tailed kin.

At Castle Lake we did some intensive trapping for what seemed to be the only individual at the Lake. We set a quantity of traps in rock slides at the end of the lake with no success until one morning Miss Alexander found a hind foot left in one of her traps. Since this proved the presence of the species we kept up the trapping and on our last morning she captured the rest of the rat—unmistakably the same animal, for he was minus a hind foot. This we had saved and so, by fastening it in its proper place, were able to preserve a complete specimen.

Twenty examples were secured (nos. 13363-13382), from the following localities: Jackson Lake, North Fork of Coffee Creek, head of Grizzly Creek, Kangaroo Creek, and Castle Lake.

Evotomys obscurus Merriam

Dusky Red-backed Mouse

Owing to lack of material for comparison it is rather difficult to determine the systematic [illegible] of the two specimens of *Evotomys* which we secured, one rat[illegible] male from Jackson Lake and one adult female from Castle [illegible]; but the two points in which these incline most strongly to the above-named species are the dull color

and the arched dorsal line of the skull in contrast to the conditions in *E. mazama,* which species is described (Bailey, 1897, p. 132) as being bright-colored and with a notably flat-topped skull. Our specimens agree with *obscurus* also in the basilar length of the skull and in the zygomatic and mastoid breadth. In external measurements our examples do not agree with *obscurus* so well, at least with the published measurements of the type of *E. obscurus;* but in a species of which so few individuals have been taken some latitude may be allowed in this respect. Our specimens measure as follows: no. 13392, ♀ adult, total length, 147 millimeters; tail vertebrae, 43; hind foot, 20. No. 13391, ♂, total length, 137; tail vertebrae, 40; hind foot, 19.5. The type specimen of *obscurus* measured (Merriam, 1897*a*, p. 72) total length, 155 millimeters; tail vertebrae, 47; hind foot, 17. Thus we see that our two specimens average smaller in total length and that of tail vertebrae, but have a longer hind foot. In this latter respect they incline toward *E. mazama,* in four specimens of which according to Merriam (1897*a*, p. 72) the hind foot measured 18.75 millimeters.

Both of our specimens were taken in dark shady places among the pines, in traps baited with oatmeal.

Microtus montanus montanus (Peale)

Peale Meadow Mouse

One specimen (no. 13404), from Mayten, Siskiyou County.

Microtus californicus californicus (Peale)

California Meadow Mouse

This meadow mouse was only taken at our two lowest summer camps, Scott River and Mayten, and in winter at Helena and Tower House. It was not at all common at Scott River, which was rather a wet place, but the dry grass in the other localities was, as usual, full of their runways. Thirty-three specimens were secured: nos. 13393-13404, 13405-13407, 12793-12811, from Helena, Tower House, Mayten and Scott River. The Helena series is perceptibly darker in tone of coloration than the specimens from elsewhere.

Microtus mordax mordax (Merriam)

Cantankerous Meadow Mouse

A series of seventy-one specimens (nos. 13408-13476) of this

long-tailed mountain meadow mouse was taken, the species proving common at all the higher camps except Castle Lake. We found them in damp meadows where they seemed to favor especially patches of hellebore with green grass growing between. No difficulty was experienced in trapping them where their runways and cuttings were much in evidence. Localities of capture are as follows: Jackson Lake, Saloon Creek divide, south fork Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, and Castle Lake.

Thomomys leucodon navus Merriam

Red Bluff Pocket Gopher

Comparatively few specimens of this species were taken, the greatest number being twenty-six from Helena (nos. 12823-12848), with five from Tower House (nos. 12849-12853). During the summer they were found at only one locality, Gazelle, Siskiyou County, where six specimens were taken (nos. 13477-13482).

The *leucodon* group is a distinct one, easily distinguishable in skull characters from its nearest relative, *laticeps*, by the whiteness of the incisors and the fact that they project more strongly forward, and by the smallness of the molars. Considerable difficulty was experienced in deciding from the published description whether or not the subspecies *navus* is a well-marked form and if so, whether our specimens belonged to it or to *leucodon*. *Navus* is described (Merriam, 1901*a*, p. 112) as being a much smaller form than *leucodon;* but a series of topotypes from Red Bluff, in the collection of the Museum of Vertebrate Zoology, shows some individuals so large as rather to eliminate size as a dependable point of distinction. Through the kindness of Mr. Henry W. Henshaw, Chief of the Biological Survey at Washington, some topotypes of *leucodon* were loaned the writer for comparison, and between the two sets of topotypes well-marked differences were seen to exist in skull characters. The comparison further indicated that the specimens from Helena and Tower House, which we have put under *navus,* are somewhat intergradient toward *leucodon.*

The coloration of specimens from Helena and Tower House in winter pelage is as follows: Above, general color bistre; lighter on sides, shading into color of underparts, which extends well up onto the sides. Underparts varying from creamy white to buff,

the slate black bases of the hairs forming a distinct dark background. Nose and region around mouth dark seal brown; throat patches, when present, and inside of pouches, white.

Coloration of specimens from Gazelle, Siskiyou County, in summer pelage is as follows: Middle of back fulvous brown, brightening into fulvous on the sides; face slightly darker than back. Underparts tawny ochraceous, except the throat and sides of head, which are bright fulvous; patches at sides of mouth seal brown; throat patch and inside of pouches white.

Thomomys monticola pinetorum Merriam

Trinity Pocket Gopher

This name seems to be applicable to a slightly marked subspecies ranging west from Mount Shasta through the higher parts of the Trinity region. As far as coloration goes I cannot say that there is much difference between *Thomomys monticola monticola* and *T. m. pinetorum,* although the latter may be considered a trifle brighter; but in skull characters, series of the two are for the most part distinguishable. The best skull character of *monticola* is the shape of the interparietal, which is about twice as broad as it is long; in *pinetorum* the interparietal is only slightly broader than its length. One point emphasized in the original description of *pinetorum* (Merriam, 1899, p. 97) is that the zygomata are much more widely spreading than in *monticola*. Our specimens do not seem to bear this out; but they do show much more distinct temporal ridges, and this we may consider a diagnostic feature of the subspecies.

A series of 182 specimens was procured (nos. 13483-13664), from the following localities: Scott River, Jackson Lake, Saloon Creek divide, North Fork of Coffee Creek, Coffee Creek, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, Castle Peak. A series of fourteen males from Rush Creek averages: total length, 210.5 millimeters; tail vertebrae, 58.7; hind foot, 28.

The coloration of a specimen from Jackson Lake in worn winter pelage may be described as dark fulvous above; the colored ends of the hairs entirely worn off in places, leaving patches of slate black; underparts light ochraceous; nose and mouth parts seal

brown; a black patch around the ear. Specimens in summer pelage are lighter fulvous above, with the dark bases of the hairs not as prominent; underparts varying from ochraceous to light buff; feet and tail whitish. Very few of the specimens are in good pelage, the majority being in ragged transition state from winter pelage to summer, or back again to winter, apparently, before the whole summer molt was completed. The impression gained was that gophers living in cultivated fields, for instance, of alfalfa, accomplish their molts much more completely than animals living in wild land, which, except in summer, are harder put to it to obtain food.

Our largest series of *pinetorum* was secured at Rush Creek. It was while trapping there that we decided that gophers are sensitive to smell, for traps set with bare hands were not so liable to catch anything as those set with gloved hands and the hole excavated with a trowel. Miss Alexander successfully tried baiting the traps by covering them and the entrance to the hole with a species of mint of which the gophers seemed to be fond. With these methods the animals were easily caught. At Jackson Lake we were particularly struck by the winter workings of the gophers. The snow was just off the ground and there had been as yet no cattle around to trample down the innumerable serpentine ridges which covered the open ground and extended even among the shrubbery under the pine trees. These ridges, or "earth plugs", consist of the earth which in winter is pushed up into the snow from underground passages, and they prove the continued activity of the gophers even during cold weather.

Dipodomys californicus trinitatis, new subspecies

Trinity Kangaroo Rat

Type.—Male adult; no. 12860, Mus. Vert. Zool.; Helena, Trinity County, California, altitude 1405 feet; February 18, 1911; collected by A. M. Alexander; original no. 1159.

Subspecific characters.—As compared with *Dipodomys californicus californicus,* coloration dark; thigh patches small; nasals long and heavy anteriorly.

Coloration.—Upperparts from between ears to band across thigh, bistre, suffused with dark buff yellow, brightening into

orange buff on the sides, and somewhat lighter between eyes; thigh patches small, same color as back, darkening towards ankle; supra-orbital white spot distinct; black ring around eye; white spot on upper edge of ear; line over nose and at base of whiskers black; upper portion of feet white, beneath seal brown; upper and lower tail stripes seal brown, the upper merging into black some distance in front of the white pencil. Underparts pure white.

Measurements.—Of type, total length, 310 millimeters; tail vertebrae, 194; hind foot, 46; height of ear, 14. Length of nasals, measured along median line, average of 12 adult males, 14.7 millimeters, average of 3 adult males of *D. californicus,* 13.5; average of 10 adult females of *D. c. trinitatis,* 14.3; average of 5 adult females of *D. californicus,* 13.5. Greatest anterior breadth of nasals, average of 12 adult males of *D. c. trinitatis,* 4.3; average of 3 adult males of *D. californicus,* 3.6; average of 10 adult females of *D. c. trinitatis,* 4.3; average of 5 adult females of *D. californicus,* 3.8.

Discussion.—This new subspecies is based chiefly on the series of fifteen skins (nos. 12854-12868) obtained at Helena. These are in winter pelage, while the 28 specimens (nos. 13665-13692) from Scott River, Siskiyou County, are on account of the difference in season slightly lighter in average coloration. In these the orange buff of the sides is more pronounced, but the skull characters are similar. The series from Helena, compared with topotypes of *californicus,* from Ukiah, Mendocino County, is distinctly darker both in the general color and, more markedly still, in the color of the dark stripes on the tail. The white of the thighs appears restricted and in the dry skins is almost concealed. Such exterior differences, however, are not so convincing as points of difference that can be readily distinguished in the skull, and in the case of this subspecies the length of the nasals and their width anteriorly are well-marked characters.

Another subspecies, *Dipodomys californicus pallidulus* (Bangs, 1899, pp. 65-66), has been described, from Sites, Colusa County; but a study of a series of topotypes of this form in the collection of the Museum of Vertebrate Zoology does not substantiate the subspecies. The characters given for *pallidulus* as compared with *californicus* are: "Color very much paler; thigh patches not dusky; . . . the black markings at base of whiskers and over nose . . . nearly wanting . . . ." A further statement (Elliot, 1901, p.

431) that the tail is "above sepia, beneath white", has no foundation in fact, as the specimens show the regulation two dark stripes, one above and one below, with an intervening white stripe on each side. It is my impression that the specimens from Sites are a trifle lighter than those from Ukiah, especially in the face, but the shade of difference is so slight that I should call them both *californicus* and simply say that individuals from Sites show a tendency toward an extreme of light coloration for the species.

Habitat.—As far as the present geographical distribution of *Dipodomys c. trinitatis* shows, the stock form may have originally worked up over the comparatively low divide from the head of the Sacramento Valley and then differentiated, because of approximate isolation, spreading in like manner to the north and east. George Knowles stated that kangaroo rats occur at Hay Fork, Trinity County; but as far as our present material goes we have no other actual record than those from the two localities at which we collected specimens.

At Helena we trapped for *Dipodomys* on the north side of the Trinity River near its junction with the north fork. For a short distance above this junction small sandy flats extend back from the banks of the river, due partly to hydraulic mining carried on in earlier days. With this exception the river runs through a narrow, rocky cañon, so that it would seem as if *Dipodomys* had here found a very limited area suited to its needs. The area of our trapping did not cover over half a mile, and was confined altogether to the north bank. We crossed the river at one point, about a mile above the junction, but although there was a sandy flat there and conditions seemed to be ideal for *Dipodomys,* we found no signs of them whatever. Where we did trap them, sign was plainly to be seen, consisting of burrows and the tracks of the animals. The prints of the hind feet showed at intervals of about twenty inches, directed to or from clumps of bushes, or around them. These bushes were manzanita and willow, and under them we set our traps. The holes were filled up with sand, evidently by the animals. Trapping was more likely to be successful when done near these holes, even though they did not look as though recently used. Many of the *Dipodomys* secured had succeeded in filling their cheek pouches full of oatmeal before being caught.

Our trapping area at Scott River was not much more extensive

than that at Helena, and was again in sandy ground, in the old bed of the Scott River, but nearly a mile back from the present main stream which, according to report, had been at one time artificially diverted to its present bed. Numerous small creeks and back waters of the river, are, however, on this side of the valley, used for irrigation. Some of the land is under cultivation, but a great deal consists of sand, overgrown with cottonwoods and willows and is used for pasture. The kangaroo rats here seemed to prefer the thicker brush for their headquarters, but Miss Alexander was most successful in securing specimens by setting the traps in a horse trail, to which the animals were no doubt attracted by the grain to be gathered from the droppings.

Zapus trinotatus alleni Elliot

Allen Jumping Mouse

A series of sixty-three specimens of this species was obtained (nos. 13696-13758), from the following localities: Jackson Lake, North Fork of Coffee Creek, Saloon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek. The series is remarkable for the freshness and uniformity of the pelage and the fact that nearly all the specimens are adult. In some groups of mice, such as *Microtus* and *Peromyscus*, nearly as many young ones as adults are taken, but in our trapping we did not take a single very young specimen of *Zapus* in spite of the fact that some of the females showed signs of having bred.

Another rather singular fact was that we never saw any signs of *Zapus*, such as runways, excrement or cuttings, and yet we caught some individuals at every camp where there were meadows or alders along running water, from an elevation of 4500 feet, on the North Fork of Coffee Creek, to our highest camp at Jackson Lake, 7200 feet. The species was most abundant at Coffee Creek, where we secured half of the whole series. We always found them in places where the vegetation was rank, generally, as just stated, under alders.

Aplodontia chryseola Kellogg

Trinity Mountain Beaver

Ten specimens secured (nos. 13324-13332, 13806) from Jackson

Lake, south fork of Salmon River, Wildcat Peak, and head of Grizzly Creek. Upon this series was based the description of *Aplodontia chryseola* as a new species showing nearest affinities with *A. californica* of the central Sierra Nevada (see Kellogg, 1914, p. 295). This species proves to be not closely related to the coast form, *A. phaea,* as its golden brown coloration might seem to indicate. Cranial and other characters lead the writer to conclude that *chryseola* is derived from *californica* stock, the latter thus having invaded the territory westwardly towards the coast through the Trinity region. For cranial characters see table of measurements, page 371, and photographs, plate 18.

Our first systematic search for signs of mountain beaver was begun at Jackson Lake, Siskiyou County. Here clumps of alder grew on sidehills from which trickled small streams of water. This seemed ideal ground for the animal, but the first real sign was found on drier ground where a runway was located between two such groups of alders. The tunnel, or runway, was finally traced direct from one alder patch to the other through a growth of wild plum, and measured seventeen meters in length. There were a dozen or more exposures of the runway. Although it seemed to be continuous, the tunnel proved, upon examination, to be disconnected at about a third of the distance, as it took a decided turn down the hill, while the one in line with it tended diagonally up hill. Before the first section of tunnel took the downward turn there was a small side exit, showing that the animals foraged abroad into the rather open wild plum grove as well as into the alder thickets. There may have been underground connections between the two sections. The first tunnel ran back into the alders, and there was no visible exit within a radius of several yards. The tunnel throughout its exposed length was dry and looked to be in recent use. In hunting among the alders we found several old burrows which now serve as underground channels for small streams.

Miss Alexander found other *Aplodontia* burrows north of Jackson Lake in alders along one of the main tributaries of Jackson Creek. In places the ground was literally honeycombed by them. In such a multiplicity of runways it was hard to select just the right places for the traps. Fresh sign was found near an old fallen tree by the stream. The tree was about forty-five feet long and the main tunnel seemed to run lengthwise underneath it with exits

TABLE OF CRANIAL MEASUREMENTS OF *Aplodontia chryseola* FROM NORTHERN CALIFORNIA

Oldest available specimen of each sex at top of column, youngest at bottom

All measurements in millimeters

Museum number	Sex	Locality	Length of nasals (1)	Width of nasals (2)	Ratio width of nasals to length	Length of incisive foramina (3)	Greatest breadth of interpterygoid fossa (4)	Length of auditory tubes (5)	Basilar length	Ratio length of auditory tubes to basilar length
13331	♂	Head Grizzly Cr., Trinity Co.	22.9	12 3	53.7	6.7	4.9	21.1	61.8	34.1
13328	♂	Jackson Lake, Siskiyou Co.	24.6	13.0	52.8	7.3	5.3	19.8	60.9	32.5
13326	♂	Jackson Lake, Siskiyou Co.	25 1	11 7	46 6	7 6	5 3	19.4	58.6	33.1
13327	♂	S. Fork Salmon R., Siskiyou Co	25.3	10.8	42.7	7.3	5.1	17.9	58.7	30.5
13329	♂	Jackson Lake, Siskiyou Co.	22.4	10.9	48.6	6.7	5.0	17.2	59.5	28 9
13330	♀	Wild Cat Peak, Siskiyou Co.	24.4	10.8	44.2	6.7	4.9	18.0	57.9	31.1
13324	♀	Jackson Lake, Siskiyou Co.	26.1	12 5	47.9	6.7	5.1	19.5	59.1	33.0
13332	♀	Head Grizzly Cr., Trinity Co	24 3	11 2	46 1	7.6	5.1	17.8	58.3	30.5
13325	♀	Jackson Lake, Siskiyou Co	25 1	10.7	42.6	6.7	4.6	16.5	57.7	28.6

[1] Most anterior point on nasal bones to most posterior point.

[2] Greatest width of nasals, across both of them.

[3] With cranium resting on its dorsal surface, rostrum pointing away from the worker, the greatest length of the foramen on the right side.

[4] Taken at expansion of interpterygoid fossa immediately back of hard palate.

[5] Most lateral point on foramen ovale to the point farthest laterally (with reference to the skull) on zygomatic side of auditory tube.

on either side, but chiefly on the water side. Two holes in the ceiling, from the neighborhood of which dirt had been scratched into a pile, exposed a passage way about fourteen inches in diameter. It was damp, but there was no running water in it, as was the case a few feet farther down in the tunnel. The fresh sign consisted in the trampled appearance of the exits, fresh cuttings of grass in them, and the broken leaves of plants at the entrance. Another runway was found with a passage leading up to a large hollow under a rock, the floor of which was strewn with alder cuttings about a foot in length. The branches were generally cut diagonally, and one was as much as half an inch in diameter. The animals seem to well deserve their name of "mountain beaver".

Miss Alexander caught three males in one limited area at Jackson Lake, but on the whole the idea that these animals live in colonies did not seem to be correct. They may do so at certain times of the year, as during the breeding season and until after the young ones are full grown; but we never trapped more than one animal at a single set of burrows.

On the Salmon River we found the mountain beavers making what we called "hay"—large bunches of green plants of various kinds cut up and spread out as if to dry and to be used later. (See pl. 16, figs. 3, 4). On a sidehill down which ran several small streams among alders and poplars there was a collection of burrows more extensive even than any found at Jackson Lake. These were situated both near the stream and out in the more open, drier ground. The runways led under roots and over rocks, with openings at short intervals, and there were plain runs out into the brush where short branches ran from each main tunnel, somewhat like a gopher working, with a dump of earth at each terminus.

Citellus douglasii (Richardson)

Douglas Ground Squirrel

Most of our camps were above the range of this ground squirrel. At Scott River it was common in the sandy ground along the numerous irrigation canals leading off from the river. We caught a good many more individuals than we wanted, especially of young ones. The weather was very warm and their greasy skins slipped quickly. The occurrence of the species at Castle Lake, however,

made them seem a little more desirable; for here they were apparently above the limit of their usual range and were found both on the dry rocky hillside above the lake and in damper ground where the creek came out from the lake; altitude 5434 feet. I presume that until the timber between Sisson and Castle Lake was cut out the ground squirrels were probably not found there. They doubtless followed the steadily retreating timber-line which resulted in unnatural conditions of dryness for such an altitude. The specimens taken at Castle Lake were in the process of molt into fresh fall pelage.

Eleven specimens were taken (nos. 13018-13028), from Mayten, Scott River, Summerville, six miles northwest of Callahan, and Castle Lake.

Eutamias amoenus amoenus (Allen)

Klamath Chipmunk

This small chipmunk was encountered at every camp. Its greatest abundance was at Jackson Lake and on Rush and Bear creeks. Here the timber conditions seemed to be just right for them, and when other material was scarce we could always depend upon the chipmunk. Ninety-six specimens were obtained (nos. 13083-13177, 13280), from the following localities: Scott River, Jackson Lake, Wildcat Peak, Salmon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, head of Deadfall Creek, Castle Lake.

Eutamias senex (Allen)

Allen Chipmunk

We found this larger chipmunk along with the smaller one at every camp, and collected a good-sized series, the bulk of it coming in at Jackson Lake, Bear Creek and Castle Lake. Our specimens differ somewhat from the description of *senex* in having the tail, below, cinnamon rufous, instead of orange; in this respect they incline toward *E. quadrimaculatus,* a form of a lower zone. But their measurements and coloration otherwise identify them unquestionably as *senex.*

One hundred and two specimens were obtained (nos. 13178-13279), from the following localities: Scott River, Jackson Lake, Wildcat Peak, North Fork of Coffee Creek, South Fork of Salmon River,

Grizzly Creek, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, Castle Lake.

Callospermophilus chrysodeirus trinitatis Merriam

Trinity Golden-mantled Ground Squirrel

The distribution of this form is given (Merriam, 1901*b*, p. 126) as "the Siskiyou, Salmon, and Trinity mountains of northwestern California and southwestern Oregon". It is described as being "much larger and darker than *chrysodeirus,* and [it] never, so far as known, develops the golden mantle which covers the head and shoulders of that species". The average measurements of six specimens from the type locality is stated to be "total length, 283; tail vertebrae, 100; hind foot, 43".

On geographical grounds one would expect the golden-mantled ground squirrels of the parts of Trinity and Siskiyou counties covered by our trip to come under this subspecies. Twelve of our specimens, males, from the various localities, average: total length, 269.6 millimeters; tail vertebrae, 96; hind foot, 41.3. An average of four specimens, male, of *C. chrysodeirus* from Mount Shasta, is; total length, 263.7; tail vertebrae, 89; hind foot, 40.7. Seven specimens, male, from near Mount Whitney, east-central California, average: total length, 276; tail vertebrae, 94; hind foot, 41.4. Three specimens, male, from Independence Lake, Nevada County, California, average: total length, 258; tail vertebrae, 78; hind foot, 41.3.

Of the three measurements, that of the hind foot seems to be the most constant, and judging from this feature as an index of size the specimens from these different regions should all be classed under the same species, namely, *chrysodeirus.* Moreover, many of our specimens show a well-developed golden color to the mantle, and, as already stated, *trinitatis* was said to lack this mantle color. On the whole, however, I should say that our series is slightly darker than those from Mount Whitney and Independence Lake, and this, even if other ascribed characters fail, might in itself justify the recognition of a form from the Trinity region. Further study of relevant material, with particular attention to changes of pelage with season, and a greater number of measurements of both body and cranium, may show that there are not sufficient grounds for recognition of a form *trinitatis.*

This squirrel was found most abundant on Saloon Creek divide, where it was the predominating species of mammal, as also at the head of Bear Creek, eleven specimens being taken at each of these localities. Its occurrence at Kangaroo Creek must have been at about the lowest limit of its range. Fifty-four specimens were taken (nos. 13029-13082), from the following localities: Jackson Lake, Wildcat Peak, North Fork of Coffee Creek, Saloon Creek divide, South Fork of Salmon River, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, and Castle Lake.

Sciurus douglasii albolimbatus Allen

Sierra Chickaree

Twenty-one specimens were taken (nos. 12738-12740, 13280-13298) representing five localities: Helena, Jackson Lake, head of Rush Creek, Bear Creek, and Castle Lake. This shows quite a range of zone from the Transition of Helena to the Boreal of Jackson Lake. Those from Bear Creek and Castle Lake, taken in August, show the light ochraceous-buff beneath, of the summer pelage.

Sciurus griseus griseus Ord

California Gray Squirrel

Helena, Trinity County, was the only locality at which we found gray squirrels, and because of the cold weather there in February they were not particularly in evidence. The seven specimens taken (nos. 12731-12737) bear dates from February 13 to 17.

Glaucomys sabrinus flaviventris Howell

Trinity Flying Squirrel

We secured our first flying squirrel at Jackson Lake in a rat-trap baited with oatmeal and set near the head of our bed. For two nights some creature had startled us by running across our faces. When we found what the intruder was, we looked carefully in all the adjacent red firs for some trace of a nest; but our knowledge of the home and habits of *Glaucomys* received no increment by actual observation during our entire trip.

Only three specimens were taken at Jackson Lake, where it may have been too early in the season for them to be out in numbers.

Coffee Creek was too low for them, but we secured one at the head of Grizzly Creek; while the largest series from any one locality, fourteen, came from Rush Creek. Five from Bear Creek and two from Castle Lake make up the total of twenty-five (nos. 13299-13323). Their occurrence at Castle Lake was one of the remarkable features of that camp; but a thick grove of red fir on a side-hill showed that the squirrels as well as the trees may have been more wide-spread there previous to the time of timber cutting. We always selected a thick growth of firs in which to set the traps, and put them at the bases of the larger trees. We often wished we could see the animals in action, but they were as noiseless and mysterious as their fur is soft and silky.

Our series shows an interesting variation in coloration and condition of pelage. As a whole, it seemed to answer quite closely to the original description of the form *klamathensis* (Merriam, 1897*b*, p. 225), and this name we had accordingly adopted. Recently our series was loaned to the United States Biological Survey where a study of the group is in progress. A preliminary paper (Howell, 1915) announces the separation of the Trinity flying squirrel as a recognizable race, the new name *flaviventris* being applied to it. The type is no. 13,319, Mus. Vert. Zool.; head of Bear Creek, 6400 feet altitude, Trinity County, California; collected August 13, 1911, by Annie M. Alexander; original number 1775.

Lepus washingtonii klamathensis Merriam

Oregon Showshoe Rabbit

One male (no. 13759), presumably adult, and an immature female (no. 13760) were taken at Bear Creek, Trinity County, August 8 and 15, respectively. In coloration and cranial characters the adult specimen agrees closely with the latest published description of *L. w. klamathensis* (Nelson, 1909, p. 107). Hitherto, as far as known to the writer, this rabbit has been recorded only from the vicinity of Fort Klamath, Oregon, and from the central Sierra Nevada of California. Our adult example, in summer pelage, may be described as follows: mixed grizzled fulvous and black above; head and face of the same fulvous but with less black; pectoral collar fulvous with a sprinkling of white; chin, throat, and belly white; a white stripe extending along the upper surface of

the hind leg on the inner side and including the toes. The skull shows the deeply grooved jugal, and small auditory bullae considered distinctive of the species. The post-orbital processes are noticeably long. In total length this specimen measures less than the average given of three specimens from Fort Klamath; but the hind foot is even longer and this may be considered a more dependable index to actual size.

Measurements of this specimen are: total length, 367 millimeters; tail vertebrae, 26; hind foot, 130; height of ear, 87. Average of 3 specimens from Fort Klamath as given by Nelson (1909, p. 108): total length, 414, tail vertebrae, 39; hind foot, 126; ear from notch, 64.

We had been told by Mr. Hinz at Summerville that snowshoe rabbits were frequently seen in that region in the winter and that they were quite abundant on the south fork of the Salmon River. We had seen no sign of them at our camp there, and had decided that only the merest chance would furnish any specimens during the summer season. Our camp at Bear Creek was on the edge of a mountain meadow, and within two hundred yards of our tent was some higher dry ground covered with small brush through which ran innumerable cattle paths. Miss Alexander was making the rounds of her small traps one day about noon, when she scared up a rabbit in this brush. It ran around a bush and then sat perfectly still in the middle of the trail. The creature was so motionless and so nearly the same color as the dried grass of the trail that he could not be seen again until he moved and then he was gone in a flash.

I set a number of small steel traps in the trails under the bushes and baited them with dried apples. The next morning the rabbit was in one of them. The young one was caught in a rat-trap set for squirrels among the trees bordering the meadow. The rest of this family were probably living in the neighborhood, but further trapping failed to secure any more specimens.

Lepus californicus californicus Gray

California Jack Rabbit

Scott River was the only camp at which we saw jack rabbits, and even here they were not especially abundant. They affected the

adjacent hillsides. Two specimens were secured (nos. 13761, 13762). A third was sent in by Mr. Knowles from Hay Fork, Trinity County (no. 12869).

Sylvilagus bachmani ubericolor (Miller)

Redwood Brush Rabbit

Mr. Knowles sent in a specimen (no. 12870) of this race of brush rabbit taken at Hay Fork, Trinity County, in March. We did not encounter it anywhere during the summer collecting.

Odocoileus columbianus columbianus (Richardson)

Columbian Black-tailed Deer

The entire region which we covered, with the exception of Mayten and Scott Valley, is supposed to constitute an excellent deer country; but our experience was that these animals had to be hunted for long and arduously and that big bucks were hard to get. The writer did not personally see a single deer during the whole summer, but the other members of the party were all more fortunate. A total of eight specimens were secured (nos. 13013-13017, 12729, 12730, 13807), from the following localities: North Fork of Coffee Creek, Summerville, head of Grizzly Creek, head of Rush Creek, Helena, Hay Fork, and Callahan.

During our stay at Helena, in February, George Knowles reported seeing a band of twenty-four deer. That was at a time of the year when they would be herding together, and, too, on account of the scarcity of feed, they would then be coming down nearer to human habitations. At Jackson Lake, in June, some men camped below us had seen a doe drinking at the stream, and Miss Alexander jumped one in the brush; also there were many fresh tracks. In spite of several nights spent by the men at the lick, near which we camped, only one young buck was shot. They said a big buck started to come in one night, but it was moonlight and he saw them before they had a chance to shoot. Mr. Baker told us he thought the deer were then feeding by moonlight and lying close in the brush during the day so that they could not be scared up unless nearly stepped upon.

As I have said, each animal secured meant a hard day's tramp over miles of country. The best specimen obtained was at Rush

Creek, a fine buck, with four points to the horns, which were in the velvet. Mr. Baker found a big hole in the body where the animal had been shot before. He says deer often get off with bad wounds, the bullet finally becoming encysted, and the animal apparently suffering no permanent ill effects. The big bucks, he claimed, along towards the end of July, go off by themselves on the high ridges, only coming down for water. The does and young ones stay more in the cañon bottoms. As is often the case in other regions, there are popular theories as to there being several different species of deer, for instance a long-legged kind and a short-legged one. But we failed to secure evidence that would go to show the presence of any true species other than *Odocoileus columbianus*.

LIST OF THE BIRDS, WITH ANNOTATIONS

Actitis macularius (Linnaeus). Spotted Sandpiper. Two adult skins (nos. 19120, 19121), from Jackson Lake, June 18 and 20.

Oxyechus vociferus (Linnaeus). Killdeer. Observed June 4 at Mayten.

Oreortyx picta picta (Douglas). Mountain Quail. Nine specimens (nos. 17299-17302, 19122-19126), from Helena, head of Bear Creek and Castle Lake. Three of these, taken August 15, 16 and 20, are juvenals, and in this plumage the characters distinguishing *picta* from *plumifera* are better shown than in the adult. These characters consist in a warmer brown suffusion dorsally and greater extent of black markings.

Numerous at nearly all of the mountain stations. On July 8, on north fork of Coffee Creek, the writer caught sight of a weasel in pursuit of a mountain quail. The bird was clucking in a distressed manner and evidently leading the enemy away from where her chicks were. When the weasel got her to a safe distance he ran back, jumped over a log, and was seen to make off with a small victim in his mouth. The whole episode did not occupy two minutes and occurred in a clearing in broad daylight.

Lophortyx californica vallicola (Ridgway). Valley Quail. Two skins (nos. 17303, 19127), from Helena and Scott River. A nest

found at the latter point, June 8, contained seventeen eggs. Seven of these occupied the center, while the remaining ten were disposed in an outer row. Observed also at Tower House.

Dendragapus obscurus fuliginosus (Ridgway). Sooty Grouse. Two skins (nos. 17304, 17305), taken at Hay Fork March 20, sent to the Museum by George Knowles. These are not typical *fuliginosus*, but show themselves to be a step nearer to this humid-coast form than the grouse of the localities enumerated under the next heading. The Trinity region evidently constitutes a part of the area of intergradation between *sierrae* and *fuliginosus* proper.

Dendragapus obscurus sierrae Chapman. Sierra Grouse. Eight specimens (nos. 19128-19135), from Callahan, north fork of Coffee Creek, Grizzly Creek, Summerville, head of Rush Creek and head of Bear Creek. One of these is a downy young, taken on July 8; three others are juveniles, taken July 18 and 25 and August 7. The females and young average very slightly browner dorsally and are more heavily marked on the breast than typical *sierrae*, thus indicating intergradation towards *fuliginosus*.

Heard drumming at Jackson Lake the third week in June, and one shot on flanks of Wildcat Peak, June 27. Brood of half-grown young seen July 18, at Summerville, where these birds are said to visit the farmyard occasionally to share the feed with the chickens. A farmer on Kangaroo Creek complained that grouse were so numerous that they were injuring his young grain. At this season, August, the grouse come down off the hillsides and collect around the margins of clearings where they prove locally destructive to crops. Abundant at head of Bear Creek during second week of August.

Zenaidura macroura marginella (Woodhouse). Western Mourning Dove. Nest and two eggs found June 5 at Mayten. A flock noted at Scott River, June 11.

Accipiter velox (Wilson). Sharp-shinned Hawk. One immature (no. 19136), from Castle Lake, August 19.

Accipiter cooperi (Bonaparte). Cooper Hawk. One immature (no. 19137), from Kangaroo Creek, August 3.

Astur atricapillus striatulus Ridgway. Western Goshawk. One adult (no. 17306), from Hay Fork, taken March 26 by George Knowles.

Falco sparverius sparverius Linnaeus. Sparrow Hawk. One

seen on Wildcat Peak, June 29, and a pair seen at Summerville, July 18.

Dryobates villosus orius Oberholser. Modoc Hairy Woodpecker. Eleven specimens (nos. 17307, 19138-19147), from Helena, Scott River, North Fork of Coffee Creek, and head of Bear Creek. This series is on the whole darker on the breast and less spotted than typical *orius,* but not to such a degree as to be referred to *harrisi,* though intergradation in this direction is indicated.

Dryobates pubescens gairdneri (Audubon). Gairdner Woodpecker. Four skins (nos. 17308, 17309, 19148, 19149), from Helena, Tower House, and Scott River. These are not typical *gairdneri,* but tend towards *turati.*

Xenopicus albolarvatus albolarvatus (Cassin). Northern White-headed Woodpecker. Two skins (nos. 19150, 19151), from Kangaroo Creek, and head of Bear Creek, August 4 and 6. Seen also on North Fork of Coffee Creek, July 8.

Sphyrapicus varius daggetti Grinnell. Sierra Red-breasted Sapsucker. Nine specimens (nos. 17310, 17311, 19152-19158), from Helena, Scott River, head of Grizzly Creek, and head of Bear Creek. Six, from the last two localities, July 23 to August 16, are juvenals.

Phloeotomus pileatus abieticola (Bangs). Northern Pileated Woodpecker. One skin (no. 17312), taken at Hay Fork by George Knowles, March 27. One seen at Jackson Lake, June 30, working on a dead pine.

Melanerpes formicivorus bairdi Ridgway. California Woodpecker. Two skins (nos. 19159, 19160), from Scott River, where common.

Asyndesmus lewisi Riley. Lewis Woodpecker. One skin (no. 19161), from head of Bear Creek, August 11. A family of the birds was here observed using as a rendezvous a dead tree standing in an open tract of chaparral.

Colaptes cafer collaris Vigors. Red-shafted Flicker. Eight skins (nos. 17313, 17314, 19162-19167), from Helena, Tower House, Jackson Lake, and head of Bear Creek. At Scott River, June 13, a bird was observed excavating a nest-cavity near the summit of a dead cottonwood. Bill-fulls of fine chips were repeatedly brought to the doorway, and allowed to scatter to the ground immediately about the tree. The bird finally emerged with an *egg* in its bill and flew off with it over the fields. The bird soon returned and resumed work upon the interior of the cavity, as evidenced from

the continual tapping from within. It is to be inferred that the egg was laid before the nest-cavity had reached its proper dimensions, and that the bird viewed the egg in the light of an obstruction, to be gotten rid of at that stage of nest-building. The species was also observed at Kangaroo Creek, August 4.

Selasphorus rufus (Gmelin). Rufous Hummingbird. Five specimens (nos. 19171, 19172), from South Fork of Salmon River, July 14, and nos. 19168, 19173, 19174, July 27, 29 and 30, from head of Rush Creek.

Stellula calliope (Gould). Calliope Hummingbird. Three skins, no. 19175, from Wildcat Peak June 30; no. 19170 from South Fork of Salmon River, July 14, and no. 19169, from Castle Lake, August 20.

Sayornis nigricans (Swainson). Black Phoebe. One skin, no. 17315, from Tower House, March 2.

Nuttallornis borealis (Swainson). Olive-sided Flycatcher. Two skins (nos. 19176, 19177), from head of Grizzly Creek, July 23.

Myiochanes richardsoni richardsoni (Swainson). Western Wood Pewee. Five specimens (nos. 19178-19182), June 9 to July 13, from Scott River, Jackson Lake, and South Fork of Salmon River.

Empidonax trailli trailli (Audubon). Traill Flycatcher. One skin, no. 19187, from Scott River, June 12.

Empidonax hammondi (Xantus). Hammond Flycatcher. Adult male, no. 19183, from South Fork of Salmon River, July 15; juvenile male, no. 19184, head of Grizzly Creek, July 23; juvenile male, no. 19186, Castle Lake, August 20.

Empidonax wrighti Baird. Wright Flycatcher. One juvenal, no. 19185, from head of Bear Creek, August 14.

Cyanocitta stelleri frontalis (Ridgway). Blue-fronted Jay. Nineteen skins, nos. 17316, 17317, 19188-19204, from Helena, Jackson Lake, North Fork of Coffee Creek, head of Grizzly Creek, head of Rush Creek, head of Bear Creek, and Castle Lake. Some of these show indications of intergradation towards the coast form *carbonacea*.

Aphelocoma californica californica (Vigors). California Jay. One skin, no. 17318, from Helena, February 24, where only two or three were noted. Observed also at Scott River, in June.

Nucifraga columbiana (Wilson). Clarke Nutcracker. One specimen, no. 19205, from head of Bear Creek, August 12. Seen at Jackson Lake, June 23 and 24, and on Wildcat Peak, June 28.

Agelaius phoeniceus nevadensis Grinnell. Nevada Red-winged Blackbird. Seven breeding adults, nos. 19206-19212, from Mayten, June 4 and 5. At this locality the species was common on marshy ground around Big Spring. For systematic treatment, see Grinnell 1914, p. 107.

Sturnella neglecta Audubon. Western Meadowlark. Observed June 4 at Mayten, and June 13 at Scott River.

Icterus bullocki (Swainson). Bullock Oriole. Three skins, nos. 19214-19216, from Mayten (June 4) and Scott River (June 11 and 12).

Euphagus cyanocephalus (Wagler). Brewer Blackbird. One skin, no. 19213, from Mayten, June 4.

Hesperiphona vespertina montana Ridgway. Western Evening Grosbeak. One specimen, no. 17319, taken at Weaverville, February 27 (see Kellogg, 1911, pp. 119-120).

Carpodacus purpureus californicus Baird. California Purple Finch. Five skins, nos. 17320, 19220-19223, from Helena (February 24), South Fork of Salmon River (July 14), and Castle Lake (August 21).

Carpodacus cassini Baird. Cassin Purple Finch. One skin, no. 19224, from Jackson Lake, June 18.

Carpodacus mexicanus frontalis (Say). California Linnet. Two specimens, nos. 19225, 19226, from Mayten and Scott River, June 4 and 11. Common at both of these stations.

Astragalinus tristis salicamans (Grinnell). Willow Goldfinch. Two skins, nos. 19227, 19228, from Scott River, June 10 and 11.

Astragalinus psaltria hesperophilus Oberholser. Green-backed Goldfinch. Three skins, nos. 19229-19231, from Scott River, June 11-13.

Spinus pinus pinus (Wilson). Pine Siskin. Four specimens, nos. 17321-17324, from Tower House, March 4 and 7. Seen also at Helena, in February.

Chondestes grammacus strigatus Swainson. Western Lark Sparrow. Three skins, nos. 19232-19234, from Scott River, June 9-11.

Passer domesticus Linnaeus. English Sparrow. Two specimens, nos. 17325, 17326, from Tower House, March 7. Seen also at Weaverville.

Zonotrichia coronata (Pallas). Golden-crowned Sparrow. Three skins, nos. 17327-17329, from Helena (February 14 and 23), and Tower House (March 8).

Spizella passerina arizonae Coues. Western Chipping Sparrow. Four specimens, nos. 19235-19238, from Scott River and South Fork of Salmon River, June 8 and 11, and July 13. Observed also at Kangaroo Creek, August 4.

Junco oreganus thurberi Anthony. Sierra Junco. Thirty-one specimens, nos. 17330-17338, 19239-19260, from the following localities: Helena, February 15 and 25; Tower House, March 1 and 2; Jackson Lake, June 17-26; north fork of Coffee Creek, July 2 and 6; South Fork of Salmon River, July 13 and 14; head of Grizzly Creek, July 21-31; Kangaroo Creek, August 4; head of Bear Creek, August 11 and 16; Castle Lake, August 19. This was the most wide-spread and abundant bird of the higher mountains during the summer.

Melospiza melodia rufina (Bonaparte). Rusty Song Sparrow. Eight skins, nos. 17343-17350, from Helena (February 15-24), and from Tower House (March 1-7). For use of this name see Kellogg (1911, p. 120).

Melospiza melodia fisherella Oberholser. Modoc Song Sparrow. Sixteen skins, nos. 17339-17342, 19261-19272, from Helena (February 16), Tower House (March 2-7), Scott River (June 8-12), Mayten (June 4 and 6), Castle Lake (August 20). Those from the first two localities were recorded (Kellogg, 1911, p. 120) under the name *merrilli*. This form of song sparrow was common on the more or less marshy ground around the Big Spring at Mayten; numerous also along the stream at the station on Scott River.

Melospiza lincolni lincolni (Audubon). Lincoln Sparrow. Eleven specimens, nos. 19273-19283, from Jackson Lake (June 21), South Fork of Salmon River (July 14), head of Rush Creek (July 27), head of Bear Creek (August 6-10).

Passerella iliaca unalaschcensis (Gmelin). Shumagin Fox Sparrow. One specimen, no. 17351, from Helena, February 17.

Passerella iliaca meruloides (Vigors). Yakutat Fox Sparrow. One skin, no. 17352, from Tower House, March 8.

Passerella iliaca megarhyncha Baird. Thick-billed Fox Sparrow. Five skins, nos. 17353-17355, 19284, 19285, from Tower House (March 2 and 7), and Castle Lake (August 19 and 21). The

latter was the only locality where any form of fox sparrow was encountered during the summertime.

Pipilo maculatus falcinellus Swarth. Sacramento Towhee. Ten specimens, nos. 17356-17358, 19286-19292, from Tower House (March 1-5), Scott River (June 9-11), and Summerville (July 18). For systematic treatment, see Swarth (1913, pp. 168, 172). A nest with young just hatching was found at Scott River, June 10. It was on the ground under a branch of a fallen yellow pine and was screened by a bunch of dead pine needles.

Pipilo crissalis carolae McGregor. Northern Brown Towhee. Three skins, nos. 17359-17361, from Helena (February 24), and Tower House (March 1 and 7). For status of this form, see Grinnell (1912, p. 199).

Oreospiza chlorura (Audubon). Green-tailed Towhee. One specimen, no. 19293, from head of Bear Creek, August 6.

Zamelodia melanocephala capitalis (Baird). Pacific Black-headed Grosbeak. Three skins, nos. 19217-19219, from Scott River, June 9-11.

Passerina amoena (Say). Lazuli Bunting. Seven skins, nos. 19294-19300, Scott River and Summerville, June 9 to July 18. Particularly plentiful at the latter locality.

Piranga ludoviciana (Wilson). Western Tanager. Five skins, nos. 19301-19305, from Scott River, Jackson Lake, Summerville, and head of Rush Creek, taken in June and July. Seen at head of Bear Creek, August 11.

Bombycilla garrula (Linnaeus). Bohemian Waxwing. Nine specimens, nos. 17362-17370, from Helena and Tower House, February 9 to March 1. For further account, see Kellogg, 1911 (pp. 120-121).

Vireosylva gilva swainsoni (Baird). Western Warbling Vireo. Four skins, nos. 19306-19309, from Scott River and Jackson Lake (in June), and Kangaroo Creek (immature, August 4).

Lanivireo solitarius cassini (Xantus). Cassin Vireo. Six skins, nos. 19310-19315, from Scott River (June 10), head of Grizzly Creek (July 23), and head of Bear Creek (August 13).

Vireo huttoni huttoni Cassin. Hutton Vireo. One skin, no 17371, from Helena, February 20.

Vermivora ruficapilla gutturalis (Ridgway). Calaveras Warbler. Ten specimens, nos. 19316-19325, from Jackson Lake, South Fork of

Salmon River, head of Grizzly Creek, and head of Rush Creek (in June and July), and Castle Lake (August 20).

Vermivora celata lutescens (Ridgway). Lutescent Warbler. Four skins, nos. 19326-19329, from head of Grizzly Creek (July 23), head of Rush Creek (July 29), head of Bear Creek (August 11), and Castle Lake (August 21).

Dendroica aestiva brewsteri Grinnell. California Yellow Warbler. Seven skins, nos. 19330-19336, from Scott River, June 8-13.

Dendroica auduboni auduboni (Townsend). Audubon Warbler. Thirteen skins, nos. 19337-19349, from Jackson Lake (June 17-25), South Fork of Salmon River (July 14), head of Grizzly Creek (July 22 and 23), head of Bear Creek (August 12 and 15).

Dendroica nigrescens (Townsend). Black-throated Gray Warbler. Three skins, nos. 19350-19352, from Scott River (June 11), and Summerville (immatures, July 18 and 19).

Dendroica townsendi (Townsend). Townsend Warbler. One immature male, in full fall plumage, no. 19353, from head of Bear Creek, August 10. Probably a migrant.

Dendroica occidentalis (Townsend). Hermit Warbler. Three immatures, nos. 19354-19356, from head of Grizzly Creek (July 23), head of Rush Creek (July 28), head of Bear Creek (August 13).

Geothlypis trichas occidentalis Brewster. Western Yellowthroat. Four breeding adults, nos. 19357-19360, from Mayten and Scott River, June 4-11. Common on the more or less marshy ground around the "Big Spring" at Mayten. Nest with four eggs found there in bunch of dry tules, June 5. Nest with four eggs found near the ground in a cornus bush, June 11, at Scott River.

Icteria virens longicauda Lawrence. Long-tailed Chat. Four skins, nos. 19361-19364, from Scott River, June 12 and 13. Here the bushes along the creek seemed alive with different birds, largely because of the chat's voluble imitations of his various neighbors.

Wilsonia pusilla chryseola Ridgway. Golden Pileolated Warbler. Nine skins, nos. 19365-19373, from Jackson Lake (June 16-18), head of Grizzly Creek (July 21), and head of Bear Creek (August 6-16).

Cinclus mexicanus unicolor Bonaparte. American Dipper. One juvenile, no. 19374, North Fork of Coffee Creek, July 5.

Thryomanes bewicki drymoecus Oberholser. San Joaquin Wren. Three adult skins, no. 17372, from Helena, February 23, and nos. 19375, 19376, from Scott River, June 11.

Troglodytes aedon parkmani Audubon. Western House Wren. Ten specimens, nos. 19377-19386, from Scott River, head of Grizzly Creek, Summerville, head of Bear Creek, and Castle Lake, June to August.

Certhia familiaris zelotes Osgood. Sierra Creeper. Ten specimens, nos. 19387-19396, from North Fork of Coffee Creek, South Fork of Salmon River, head of Grizzly Creek, and head of Bear Creek, July and August.

Sitta carolinensis aculeata Cassin. Slender-billed Nuthatch. Two skins, nos. 19397, 19398, from Scott River, June 13.

Sitta canadensis Linnaeus. Red-breasted Nuthatch. Three skins, nos. 19399-19401, from head of Rush Creek (July 28), and head of Bear Creek (August 6 and 10).

Baeolophus inornatus inornatus (Gambel). Plain Titmouse. Three skins, nos. 17373, 17374, from Tower House, March 2, and no. 19402, from Scott River, June 9.

Penthestes atricapillus occidentalis (Baird). Oregon Chickadee. Four skins, nos. 19403-19406, from Scott River, six miles northwest of Callahan, June 10 and 13. Two are adults and two juvenals not fully grown, one of each on each of the two dates. This is the first unquestionably authentic record of this species for California.

Penthestes gambeli gambeli (Ridgway). Mountain Chickadee. Twenty-two skins, nos. 19407-19428, from Jackson Lake, south fork of Salmon River, head of Grizzly Creek, head of Rush Creek, Kangaroo Creek, head of Bear Creek, and Castle Lake, June 16 to August 19.

Penthestes rufescens rufescens (Townsend). Chestnut-sided Chickadee. One skin, no. 17375, from Helena, February 15. Apparently numerous at this time and place, but not seen anywhere in the Trinity region during the summer.

Psaltriparus minimus minimus (Townsend). Coast Bush-tit. Five skins, nos. 17390-17392, 19429, 19430, from Tower House, March 7, and Scott River, June 8 and 11. For systematic status, see Swarth (1914, p. 510).

Chamaea fasciata henshawi Ridgway. Pallid Wren-tit. Fifteen specimens, nos. 17376-17389, from Helena and Tower House, Feb-

ruary 20 to March 7, and no. 19431, from Scott River, June 11. Most numerous at Tower House.

Regulus satrapa olivaceus Baird. Western Golden-crowned Kinglet. Seven skins, nos. 17432-17438, from South Fork of Salmon River (July 14 and 16), head of Grizzly Creek (July 21-23), and head of Rush Creek (July 27).

Regulus calendula (Linnaeus). Ruby-crowned Kinglet. Four skins, no. 17393, from Helena (February 14), no. 17394, from Tower House (March 7), no. 19439, from South Fork of Salmon River (July 16), and no. 19440, from head of Bear Creek (August 13).

Myadestes townsendi (Audubon). Townsend Solitaire. Five skins, nos. 17395, 17396, from Helena (February 14 and 23), no. 17397, from Tower House (March 1), no. 19441, from North Fork of Coffee Creek (July 3), and no. 19442, from Kangaroo Creek (August 4).

Hylocichla ustulata ustulata (Nuttall). Russet-backed Thrush. Two adult skins, nos. 19443, 19444, from Jackson Lake (June 25), and head of Grizzly Creek (July 23). Nest and four eggs (no. 1097) taken at Jackson Lake, June 25. This was situated three feet above the ground on a sagging branch of a small fir, and was loosely constructed of dry fir twigs, dead ferns and moss.

Hylocichla ustulata swainsoni (Tschudi). Olive-backed Thrush. One adult male, no. 19447, from head of Grizzly Creek, 6000 feet altitude, July 22.

Hylocichla guttata nanus (Audubon). Dwarf Hermit Thrush. Seven skins, nos. 17398-17404, from Helena and Tower House, February 13 to March 7.

Hylocichla guttata slevini Grinnell. Monterey Hermit Thrush. Two specimens: no. 19445, female juvenal, head of Rush Creek, July 29; no. 19446, female immature, head of Bear Creek, August 12.

Planesticus migratorius propinquus (Ridgway). Western Robin. Eight skins, nos. 17405, 17406, 19448-19453, from Helena (February 24), Mayten (June 5), Jackson Lake (June 19 and 24), and head of Bear Creek (August 10 and 16). At the latter locality and dates robins had gathered in flocks, feeding in the ceanothus brush.

Ixoreus naevius naevius (Gmelin). Varied Thrush. Three skins, nos. 17407-17409, from Helena and Tower House, February 13 to March 7.

Sialia mexicana occidentalis Townsend. Western Bluebird. Three specimens: nos. 17410, 17411, from Tower House, March 2; no. 19454, from Scott River, June 13. Common at Tower House in March, but notably scarce in summer throughout the Trinity region.

Sialia currucoides (Bechstein). Mountain Bluebird. One adult male, no. 19455, from Wildcat Peak, June 28.

Transmitted June 27, 1914.

LITERATURE CITED

Bailey, V.

1897. Revision of the American voles of the genus *Evotomys*. Proc. Biol. Soc. Wash., 11, 113-138, pl. 3.

Bangs, O.

1899. Descriptions of some new mammals from western North America. Proc. New England Zool. Club, 1, 65-72.

Elliot, D. G.

1901. A synopsis of the mammals of North America and the adjacent seas. Field Columbian Mus., Zool. Ser., 2, pp. vx + 471, 49 pls., 94 figs. in text.

Grinnell, J.

1912. The northern brown towhee. Condor, 14, 199.

1914. A new red-winged blackbird from the Great Basin. Proc. Biol. Soc. Wash., 27, 107-108.

Howell, A. H.

1914. Revision of the American harvest mice (genus Reithrodontomys). U. S. Dept. Agric., Bur. Biol. Surv., N. Amer. Fauna, 36, 97 pp., 7 pls., 6 figs. in text.

1915. Descriptions of a new genus and seven new races of flying squirrels. Proc. Biol. Soc. Wash., 28, 109-114.

Kellogg, L.

1911. A collection of winter birds from Trinity and Shasta counties, California. Condor, 13, 118-121.

1914. *Aplodontia chryseola*, a new mountain beaver from the Trinity region of northern California. Univ. Calif. Publ. Zool., 12, 295-300.

Merriam, C. H.

1890. Descriptions of twenty-six new species of North American mammals. U. S. Dept. Agric., Div. Orn. and Mamm., N. Amer. Fauna, 4, pp. v + 60, 3 pls., 3 figs. in text.

1896. Synopsis of the weasels of North America. *Ibid.*, 11, 44 pp., 5 pls., 16 figs. in text.

1897*a*. Descriptions of two new red-backed mice (*Evotomys*) from Oregon. Proc. Biol. Soc. Wash., 11, 71-72.

1897*b*. Description of a new flying squirrel from Ft. Klamath, Oregon. *Ibid.*, 11, 225.

1899. Results of a biological survey of Mount Shasta, California. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, 16, 179 pp., 5 pls., 46 figs. in text.

1901*a*. Descriptions of twenty-three new pocket gophers of the genus *Thomomys*. Proc. Biol. Soc. Wash., 14, 107-117.

1901*b*. Two new rodents from northwestern California. *Ibid.*, 14, 125-126.

NELSON, E. W.

1909. The rabbits of North America. U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna, 29, 314 pp., 13 pls., 19 figs. in text.

SWARTH, H. S.

1913. A revision of the California forms of *Pipilo maculatus* Swainson, with description of a new subspecies. Condor, 15, 167-175, 1 map.

1914. A revision of the bush-tits of California. Auk, 31, 499-526, 1 pl.

PLATE 15.

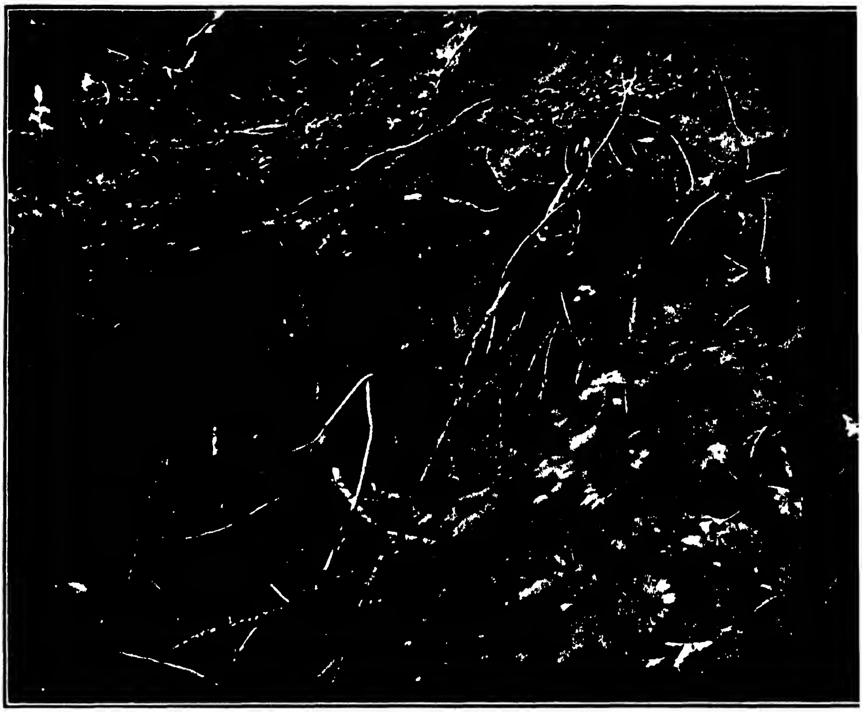
Fig. 1. View towards the east, of a portion of Scott River Valley, Siskiyou County, California, about six miles north of Callahan, altitude about 3,000 feet Photograph taken June 13, 1911. The floor of the valley is timbered with yellow pine, cottonwood and willow. The hills shown in the picture were not visited, but looked much drier and were decidedly more sparsely timbered than the hills on the west side, at the base of which camp was located These western hills were well covered with sage-brush, deer-brush and scattering groves of yellow pine. The sandy ground of an old creek bed proved to be good trapping ground for *Dipodomys californicus trinitatis*. Other small mammals of the lower lands were *Peromyscus maniculatus gambelii*, *Eutamias amoenus amoenus*, *Eutamias senex*, and *Citellus douglasii* On the sidehill *Lepus californicus californicus* was common *Dryobates pubescens gairdneri*, *Astragalinus tristis salicamans*, *Astragalinus psaltria hesperophilus*, *Chondestes grammacus strigatus*, *Melospiza melodia fisherella*, *Pipilo maculatus falcinellus*, *Zamelodia melanocephala capitalis*, *Dendroica aestiva brewsteri*, *Icteria virens longicauda* and *Penthestes atricapillus occidentalis* were birds which frequented the willow thickets along the small creek beds On the sidehill were seen *Lophortyx californica vallicola*, *Melanerpes formicivorus bairdi* and *Piranga ludoviciana* The life-zone may be considered mixed Upper Sonoran and Transition, prevalently the former.

Fig 2 North side of Saloon Creek divide, Siskiyou County, California, altitude 6,275 feet. Photograph taken July 10, 1911. A scattering growth of silver pine and red fir on sidehill, and patches of alder along creek bottom. As a collecting station the locality was chosen chiefly because of the presence there of a colony of the golden-mantled ground squirrel (*Callospermophilus chrysodeirus trinitatis*). The small Klamath chipmunk (*Eutamias amoenus amoenus*) was almost as numerous and there was abundant sign of gophers (*Thomomys monticola pinetorum*). The life-zone here represented was the Canadian division of the Boreal.

PLATE 16.

Fig. 3. Burrows of the Trinity mountain beaver (*Aplodontia chryseola*) near Hunters' Camp, Grizzly Creek Cañon, Trinity County, California. Photograph taken July 19, 1911. The animals had taken advantage of the protection afforded by the tangled roots of a fallen tree. Although the ground was here dry, there was running water within a few yards to one side.

Fig. 4. Mouth of burrow of *Aplodontia chryseola*, showing heap of freshly-cut vegetation. Photograph taken near Hunters' Camp, Grizzly Creek Cañon, Trinity County, California, July 19, 1911. The presence in this locality, as well as at several other points, of cuttings of grass and leaves seems to establish the fact that these mammals gather and dry vegetable materials for subsequent use.



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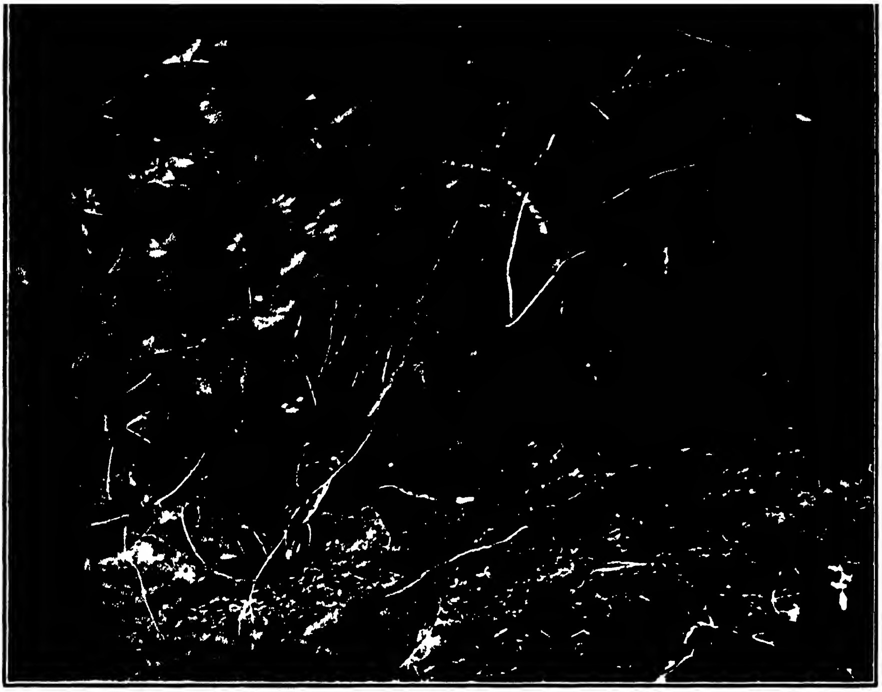

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PLATE 17.

Fig. 5. View taken July 23, 1911, looking towards head of Grizzly Creek, Trinity County, California, altitude about 6,000 feet. The timber is white pine, red fir, and hemlock, scattered through a meadow and reaching up on the rocky slopes of Thompson Peak, the summit in the background. A bank of perpetual snow feeds a lake from which a waterfall (shown in left center) descends to form Grizzly Creek. Small mammals were not numerous but included *Microtus mordax mordax*, *Zapus trinotatus alleni*, and the two species of *Eutamias*, *amoenus* and *senex*. *Aplodontia chryseola* was fairly abundant on the west side of the cañon, and a number of black-tailed deer were seen in the neighborhood. Birds noted were: *Nuttallornis borealis*, *Cyanocitta stelleri frontalis*, *Junco oreganus thurberi*, *Lanivireo solitarius cassini*, *Vermivora rubricapilla gutturalis*, *Vermivora celata lutescens*, *Dendroica auduboni auduboni*, *Dendroica occidentalis*, *Certhia familiaris zelotes*, *Penthestes gambeli gambeli*, *Regulus satrapa olivaceus*, *Hylocichla ustulata ustulata*, *Hylocichla ustulata swainsoni* (one specimen). The life-zone represented is evidently Boreal, in its Canadian and Hudsonian divisions.

Fig. 6. View taken July 31, 1911, looking southwest from head of Rush Creek, Siskiyou County, California, towards the Salmon Mountains; altitude about 6,400 feet. A typical Boreal meadow of luxuriant grasses, with thickets of alder and patches of hellebore. Red firs skirt the edge of the meadow and, interspersed with hemlock, extend in dense stand to the top of the divide. Below the meadow the silver pine and cedar predominate. Small mammals taken in and near the meadow were: *Sorex vagrans amoenus*, *Peromyscus maniculatus gambelii*, *Microtus mordax mordax*, *Thomomys monticola pinetorum* and *Zapus trinotatus alleni*. *Glaucomys sabrinus flaviventris* was abundant in the groves of red fir, and in a side cañon three marten (*Martes caurina caurina*) were secured. Birds were confined chiefly to the meadow and its vicinity, and included *Oreortyx picta picta*, *Dendragapus obscurus sierrae*, *Cyanocitta stelleri frontalis*, *Junco oreganus thurberi*, *Melospiza lincolni lincolni*, *Dendroica occidentalis*, *Penthestes gambeli gambeli* and *Hylocichla guttata slevini*.

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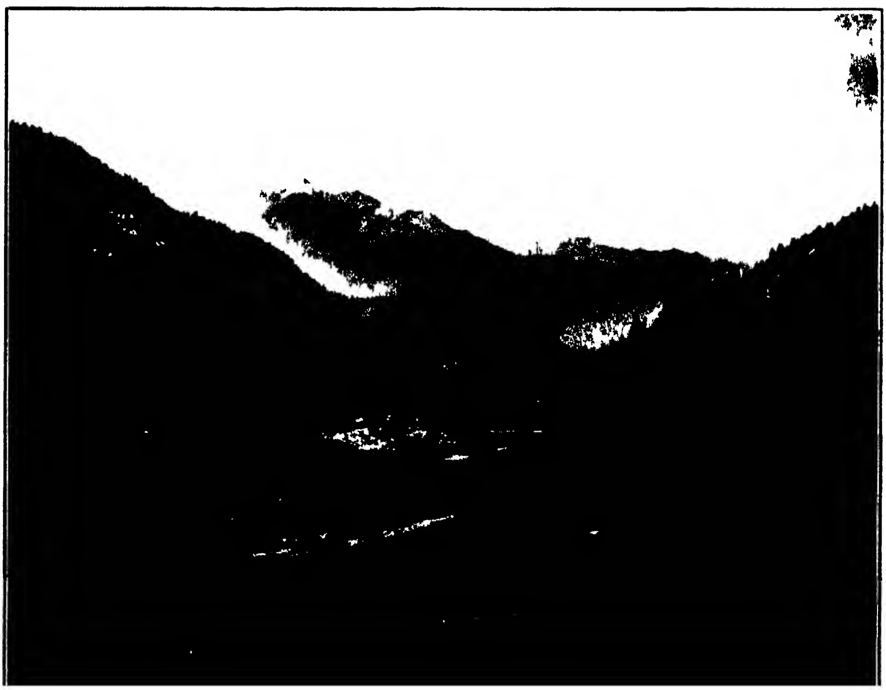


PLATE 18.

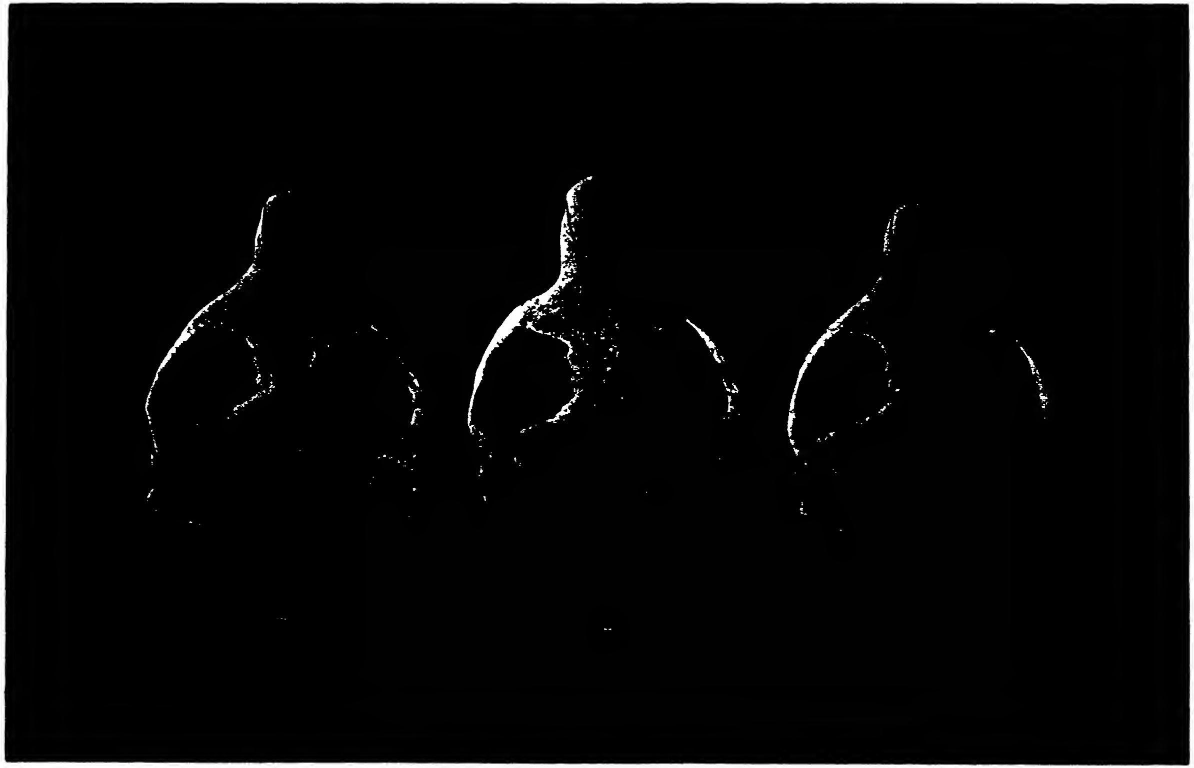
Skulls of *Aplodontia;* all × 0.62.

Fig. 7. *A. chryseola* Kellogg· ♂, no. 13331, Mus. Vert. Zool., head ot Grizzly Creek, Trinity County, California.

Fig. 8. *A. californica* (Peters): ♂, no. 18663, Mus. Vert. Zool, Blue Cañon, Placer County, California.

Fig. 9. *A. chryseola* Kellogg· ♂, type, no. 13328, Mus. Vert. Zool., Jackson Lake, Siskiyou County, California.

Note in *A. chryseola* (the two end skulls): the short rostrum, short and broad nasals, expanded frontal region, broad rostrum posteriorly, less squarish zygomatic arch, broad interorbital constriction, and lengthened auditory tubes.



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AN ANALYSIS OF THE VERTEBRATE FAUNA OF THE TRINITY REGION OF NORTHERN CALIFORNIA

BY

JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

From the array of facts presented in the foregoing paper (Kellogg, 1916), in conjunction with what is known of adjacent areas, it seems possible to draw some general inferences as to the composition and derivation of the vertebrate fauna of the Trinity region. Faunas vary through a wide range in degree of distinctness, from that which is scarcely different from the one or ones adjacent, to the fauna which is of marked peculiarity, showing throughout nearly all its elements totally distinct characters. An example of the latter would be the San Diegan fauna as compared with the adjacent Colorado Desert fauna (see Grinnell and Swarth, 1913, page 388). Of far less degree of difference, we may cite the Santa Cruz faunal division of the Humid Coast Belt as compared with the Marin division of the same belt.

The difficulties arising in attempts to diagnose and properly classify faunas are surprisingly similar to those encountered in dealing with subspecies, species, genera and other systematic groups. Not only is there such wide variability in amounts of difference between faunas as to make the matter of rank often indeterminable, but exact geographic boundaries may be impossible to fix because of intergradation over intermediate territory of greater or less width. As in some cases of intergrading series of subspecies, the location of lines of separation may be subject only to arbitrary choice, so that where six faunas might be recognized by one student, only three would be thought properly distinguishable by another.

The fauna of the Trinity region seems to be best dealt with, by considering its Boreal zonal elements, and its Sonoran (or Austral) zonal elements, separately. Adjacent Boreal faunas are those of: (1) the Sierra Nevada of east central California, (2) the Cascades of Oregon, (3) the Humboldt Bay division of the Humid Coast Belt. Adjacent Sonoran faunas are those of: (1) the Sacramento Valley, (2) the Modoc region of northeastern California, (3) the Humid Coast Belt. The following tabulations will serve to segregate the pertinent facts appropriately:

Table 1. Boreal species of the Trinity region which occur also on both the Sierra Nevada and the Cascade Mountains, but not as regular members of the humid coast fauna.

MAMMALS

Canis lestes (there are indications that a separate form exists in the area towards the coast from Mount Shasta, of which the Trinity region is a part).
Martes caurina caurina (subspecific status in doubt; probably differing from the Cascade animal and most nearly identical with a Sierran race).
Martes pennanti pacifica (subject to same remark as above).
Microtus mordax mordax.
Eutamias amoenus amoenus.
Eutamias senex.
Callospermophilus chrysodeirus trinitatis (very slightly different from *C. c. chrysodeirus* of the Sierras and Cascades).

BIRDS

Dryobates villosus orius (intergradient towards the humid coast form *harrisi*).
Xenopicus albolarvatus albolarvatus.
Asyndesmus lewisi (possibly not to be considered Boreal).
Stellula calliope.
Empidonax wrighti (possibly a straggler, merely).
Nucifraga columbiana.
Carpodacus cassini.
Melospiza lincolni lincolni.
Oreospiza chlorura.
Vermivora ruficapilla gutturalis.
Dendroica auduboni auduboni.
Dendroica nigrescens (not strictly Boreal).
Dendroica occidentalis.
Certhia familiaris zelotes.
Penthestes gambeli gambeli.
Myadestes townsendi.
Sialia currucoides.

Table 2. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives on the Sierra Nevada, but not on the Cascades.

MAMMALS

Sorex vagrans amoenus (very slightly differentiated from *S. v. vagrans*, of the humid coast belt and the Cascades).
Mustela muricus.
Microtus montanus montanus (found only at Mayten; occurs also in the Klamath region at extreme southern end of Cascades).
Thomomys monticola pinetorum (very slightly different from *T. m. monticola* of the Sierra Nevada).
Zapus trinotatus alleni.
Aplodontia chryseola (decidedly different from *A. californica* of the Sierra Nevada).
Sciurus douglasii albolimbatus.
Glaucomys sabrinus flaviventris.

BIRDS

Dendragapus obscurus sierrae (intergradient towards the humid coast form *fuliginosus*).
Sphyrapicus varius daggetti.
Cyanocitta stelleri frontalis (slightly intergradient towards the coast form *carbonacea*).
Junco oreganus thurberi.
Passerella iliaca megarhyncha.

Table 3. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives on the Cascade Mountains, but not on the main Sierra Nevada.

MAMMALS

Mustela saturata.
Neotoma cinerea occidentalis (occurs also on northern Sierra Nevada and locally to the coast).
Evotomys obscurus (also on extreme northern Sierra Nevada).
Lepus washingtonii klamathensis (the snowshoe rabbit reported under this name from the central Sierra Nevada, is probably distinct from *klamathensis*).

BIRDS

(none)

Table 4. Boreal species of the Trinity region which are identical with, or show closest affinities to, representatives in the humid coast belt.

MAMMALS

Scapanus latimanus latimanus (wide ranging zonally to the southward through the coast ranges; not a typical humid coast form; group relationships not yet worked out satisfactorily).

Neurotrichus gibbsi major (status of races not worked out satisfactorily; while the genus belongs to the northwest coast belt, there may prove to be a Sierran subspecies with which the Trinity animal belongs).

Sorex montereyensis montereyensis (but slightly different from the Sierran form, *S. m. mariposae*).

Lynx fasciatus.

Odocoileus columbianus columbianus.

BIRDS

Oreortyx picta picta.

Dendragapus obscurus fuliginosus (intergradient towards the Sierran form *sierrae*).

Melospiza melodia rufina (in winter, only).

Penthestes atricapillus occidentalis.

Penthestes rufescens rufescens (in winter, only?).

Hylocichla guttata slevini.

Table 5. Boreal species of the Trinity region which appear to be endemic, that is, different from related forms in either the Sierra Nevada, the Cascades, or the humid coast belt.

MAMMALS

Thomomys monticola pinetorum (extends also to Mount Shasta).

Aplodontia chryseola.

Callospermophilus chrysodeirus trinitatis.

Glaucomys sabrinus flaviventris.

BIRDS

(none)

Table 6. Sonoran species of the Trinity region which belong to variable groups and which are identical with, or show nearest affinities to, representatives in the Sacramento Valley.

MAMMALS

Bassariscus astutus raptor (extends also through the coast ranges to the southward and into Oregon on the north).

Spilogale phenax phenax (wide-ranging through the coastal region to the south).

Mephitis occidentalis occidentalis (wide-ranging through many faunas to the south).

Peromyscus boylii boylii.

Peromyscus truei gilberti.

Microtus californicus californicus.

Thomomys leucodon navus.

Dipodomys californicus trinitatis (slightly different from the form *D. c. californicus* of the upper Sacramento Valley).

Lepus californicus californicus (also ranges locally nearly or quite through the coast belt).

BIRDS

Lophortyx californica californica.
Astragalinus tristis salicamans (also in humid coast belt).
Astragalinus psaltria hesperophilus.
Chondestes grammacus strigatus (occurs also in the Great Basin).
Pipilo maculatus falcinellus.
Pipilo crissalis carolae.
Thryomanes bewicki drymoecus.
Baeolophus inornatus inornatus.
Chamaea fasciata henshawi.

Table 7. Sonoran species of the Trinity region which belong to variable groups, and which are identical with, or show nearest affinities to, representatives in the Modoc region.

MAMMALS

Reithrodontomys megalotis klamathensis.

BIRDS

Agelaius phoeniceus nevadensis (found at Mayten only, in Shasta Valley; so not really a bird of the Trinity region as explicitly defined).
Melospiza melodia fisherella.

Table 8. Sonoran species of the Trinity region which belong to variable groups and which are identical with, or show nearest affinities to, representatives in the humid coast belt.

MAMMALS

Neotoma fuscipes fuscipes (not exclusively a humid coast form; ranges across head of Sacramento Valley).
Sylvilagus bachmani ubericolor (extends also interiorly across head of Sacramento Valley).

BIRDS

Dryobates pubescens gairdneri (tending towards the race *turati*, of the Sacramento Valley and other faunas to the southward).
Psaltriparus minimus minimus (ranges somewhat beyond the most restricted confines of the humid coast belt).

Table 9. Sonoran species of the Trinity region which are apparently endemic, that is, different from related forms in any of the other faunas.

MAMMALS

Dipodomys californicus trinitatis.

BIRDS
(none)

Table 10. Species which are either so widespread through all the faunas here concerned as to be non-significant in the present study, or which are of unknown status.

MAMMALS

Myotis longicrus longicrus.
Lasionycteris noctivagans.
Eptesicus fuscus fuscus.
Ursus americanus.
Urocyon cinereoargenteus townsendi (merging into the races *U. c. californicus* and *U. c. sequoiensis* immediately to the south of the Trinity region).
Procyon psora pacifica.
Mustela vison energumenos.
Felis oregonensis oregonensis.
Peromyscus maniculatus gambelii (slightly intermediate towards the humid coast form *rubidus*).
Citellus douglasii.
Sciurus griseus griseus (apparently non-differentiated in the three Boreal faunas here concerned!).

BIRDS

Actitis macularius.
Oxyechus vociferus.
Zenaidura macroura marginella.
Accipiter velox.
Accipiter cooperi.
Astur atricapillus striatulus.
Falco sparverius sparverius.
Phloeotomus pileatus abieticola.
Melanerpes formicivorus bairdi.
Colaptes cafer collaris (not approaching the northern humid coast form *saturatior*).
Selasphorus rufus (probably a migrant, only).
Sayornis nigricans (in winter, only, and not in the main Trinity region.
Nuttallornis borealis.
Myiochanes richardsoni richardsoni.
Empidonax trailli trailli.
Empidonax hammondi (not certainly breeding).
Aphelocoma californica californica.
Sturnella neglecta.
Icterus bullocki.
Euphagus cyanocephalus.
Hesperiphona vespertina montana (probably only in winter).
Carpodacus purpureus californicus.
Carpodacus mexicanus frontalis.
Spinus pinus pinus.
Passer domesticus.
Zonotrichia coronata (in winter, only).
Spizella passerina arizonae.
Passerella iliaca unalaschcensis (in winter, only).
Passerella iliaca meruloides (in winter, only).
Zamelodia melanocephala capitalis.
Passerina amoena.

Piranga ludoviciana.
Bombycilla garrula (in winter, only).
Vireosylva gilva swainsoni.
Lanivireo solitarius cassini.
Vireo huttoni huttoni.
Vermivora celata lutescens.
Dendroica aestiva brewsteri.
Dendroica townsendi (probably a transient, only).
Geothlypis trichas occidentalis.
Icteria virens longicauda.
Wilsonia pusilla chryseola.
Cinclus mexicanus unicolor.
Troglodytes aedon parkmani.
Sitta carolinensis aculeata.
Sitta canadensis.
Regulus satrapa olivaceus.
Regulus calendula.
Hylocichla ustulata ustulata.
Hylocichla ustulata swainsoni (possibly an exceptional occurrence).
Hylocichla guttata nanus (in winter, only).
Planesticus migratorius propinquus.
Ixoreus naevius naevius (in winter, only).
Sialia mexicana occidentalis.

Kellogg (1916) lists 47 mammals and 95 birds from the Trinity region, a total of 142 vertebrate species. In spite of the very high grade of field-work carried on by Misses Alexander and Kellogg during the time of their exploration in the region, it is not for a moment to be inferred that this is the total number of mammal and bird species regularly occurring in the region. But it is the *known* fauna. A few included species may prove to be stragglers and not really to be considered in faunal analysis. Obviously the present assignment of species must be accepted only as provisional; at the same time it is probable that the general situation as regards proportional constituency of the various categories of species would remain very nearly the same as here indicated, even after such intensive and long-continued survey as might be devoted to the Trinity region in the future. Increments from future field-work would be likely to be distributed pretty evenly among the several categories so that the ratios would continue but little if any changed.

As indicated in the foregoing tables, 65 species out of the total 142 are either widespread through all the faunas here concerned or are of unknown status, in either case being removed from consideration in any attempt to establish *differences* between the faunas. This disposes at once of 46 percent of the Trinity fauna.

As is well known, the appertaining faunas of greatest contrast are those of the humid coast belt and the Sierra-Cascades. Twenty-four Boreal species, or 17 percent of the Trinity mammals and birds, occur also on both the Sierra Nevada and the Cascade Mountains, but not regularly as elements of the humid coast fauna. Also there are thirteen species, or 9 percent, of the Trinity boreal fauna which are identical with, or show closest affinities to, representatives on the Sierra Nevada, but not on the Cascades; and there are four species, or 3 percent, of the Trinity Boreal fauna which are identical with, or show closest affinities to, representatives on the Cascade Mountains, but not on the main Sierra Nevada. Mount Shasta is here considered as properly included in the Sierran fauna. This mountain, in spite of its relative isolation, certainly shows only minor differences from the main central Sierras (see Merriam, 1899, pp. 71-81).

It is thus to be seen that a total of 41 mammals and birds, or 28 percent of its species, are shared by the Trinity fauna exclusively with that of both the Sierras and Cascades together. On the other hand, there are only eleven, or less than 8 percent, of the Trinity species which are shared exclusively with the closely adjacent humid coast fauna. As regards its Boreal elements, therefore, we may conclude that the Trinity fauna is much more nearly allied to the Sierra-Cascades than to the humid coast belt.

The fauna of the Trinity region is preponderantly Boreal; much the larger part of the territory lies in the Transition and Canadian life-zones. The strictly Sonoran (Upper Sonoran) elements occur only in the valleys of low altitude. Of these there are three, of small area, situated in the interior of the region: Scott River, south fork of the Salmon River at Summerville, and Trinity River in the vicinity of Helena; and two on the borders: Shasta Valley, in which Mayten is situated, and the upper extremity of the Sacramento Valley in the vicinity of Tower House. Taking into account chiefly the Sonoran "islands", we find that the Trinity region possesses 18 species in common with the Sacramento Valley. This is somewhat less than 12 percent of the total mammal and bird fauna of the Trinity area. Three species, or little more than 2 percent, are shared with the Modoc region of extreme northeastern California (and which has its western confines in Shasta Valley); while only four Sonoran species, not quite 3 percent, occur also in the humid coast belt.

It would thus appear that, as regards its Sonoran fauna, the Trinity region allies itself strongly with the Sacramento fauna rather than with either of the other two named.

As far as specimens have become available and carefully studied (Kellogg, 1916), only five endemic forms have been found, all mammals. Four of these are Boreal: *Thomomys monticola pinetorum* Merriam, *Aplodontia chryseola* Kellogg, *Callospermophilus chrysodeirus trinitatis* Merriam, and *Glaucomys sabrinus flaviventris* Howell; one is Sonoran: *Dipodomys californicus trinitatis* Kellogg. Only one of the five is well-marked, the *Aplodontia,* the other four being but faintly characterized. This indicates a differentiation center of weak power.

It is apparent that the Trinity region shows but weak faunal individuality. It is not sharply set off, except on the west, nor does it contain notably distinct forms. This relative unimportance as a differentiation center is doubtless due to its small area and to the lack of efficient barriers which would prevent intercrossing with representatives in adjacent faunas. No very low zone is interposed, the Transition, merely, being continuous between the Boreal areas. The climatic features, too, are clearly not so pronouncedly different from those of the Sierra Nevada as to make up for the very short distance between the main Trinity mass and the Sierras.

There must be a very abrupt line of demarcation between the Trinity fauna and the humid coast fauna, for we have very few forms venturing from the latter into the former, in spite of the very short distance. It is true that with a few birds we find intergrades in the Trinity region between typical Sierran and typical coast-belt forms; for example, in the genera *Dendragapus, Dryobates* and *Cyanocitta.* But in by far the greater number of appropriate cases, in both birds and mammals, the Trinity representatives are unequivocally of interior forms, and this in spite of the fact that practically all of the Trinity drainage is west directly to the Pacific and lies within a maximum distance of ninety miles of the coast. The climatic barrier, of abruptly and greatly increased humidity on the west, is evidently much more efficient in checking the spread of species than the various Transition-zone "gaps" between the mountain masses of the interior or the Transition-zone divides between the "islands" of Upper Sonoran.

The whole idea of basing the efficacy of zonal "gaps" on the summation of the species occurring on either side (see Merriam,

1899, pp. 69-86) must to the writer's mind be reconsidered. Zone must be thought of in conjunction with conditions of varying humidity, associational features, and relative sizes of all the segregated areas concerned. Species may be delimited in their ranges by other factors than that of temperature. This remark is not, however, meant as implying a denial that temperature is the one factor most frequently limiting the ranges of species. A narrow Transition-zone gap between two Boreal areas, as that at Sisson, between mounts Eddy and Shasta, cannot serve as a particularly effective barrier between the Boreal species encountering it, unless it be coupled with, on opposite sides, marked differences in humidity or associational conditions, which, however, do not appear to exist in the present instance.

The problem here arises, how to treat the Trinity region in faunal nomenclature. What is the criterion for nominal separation of faunas? What percentage of its species have to be peculiar, or what minimum ratio of differences obtain in comparison with the animal life of adjacent areas, to render the Trinity assemblage of forms worthy of separate recognition by name on our fanual maps? Mount Shasta has but two mammals and two birds (even these doubtful), which do not occur on the central Sierras; it is chiefly characterized by absence of forms (due to its small area). We are therefore led to include Mount Shasta with the Sierra Nevada in the "Sierra Nevadan Faunal Area". But we do not hesitate to recognize as distinct the Cascade fauna and the Sierra Nevadan fauna. And the Humid Coast fauna is conspicuously peculiar.

The difficulties here encountered have been alluded to in a preceding paragraph. The Trinity region in its vertebrate animal life resembles much more closely the Sierras than the Cascades; it is in a way intermediate, but has in addition some humid coast elements. The differences between the Trinity and Sierran faunas are concerned with only eleven percent of its species all told. Is this a sufficient *amount* of difference to warrant their recognition as distinct faunal areas, as indicated on a current distributional map (Grinnell, 1913, pl. 16)? Possibly not, though the writer believes that for purposes of faunal analysis such fine distinctions may be useful. It will depend on circumstances, for, with wider problems in view, it might for the moment be better to lump the Trinity area in with the Sierra Nevada under a common designation. Expediency will fix the criterion for recognizing faunal division, and this may

vary as circumstances vary, just as with the recognition of genera, families, etc. The term subfauna has been previously employed for the more slightly characterized assemblages of animal inhabitants, and this might be a useful term to adopt regularly in connection with such minor faunal divisions as that of the Trinity region.

The exact location of boundaries for the Trinity subfauna is a matter of uncertainty. This uncertainty arises from two circumstances: first, that, as experience elsewhere would lead one to expect, there are broad marginal belts of intermingling, rather than sharp lines of demarcation; and, second, lack as yet of exploration of much of the surrounding territory. No field-work has been done by anyone connected with the California Museum of Vertebrate Zoology on a line directly to the coast west from the Salmon Mountains. To the north, the Siskiyou Mountains, across the deep Klamath River cañon, are so far known only as regards their birds (see Anderson and Grinnell, 1903). The birds are indicative of close faunal similarity of the Siskiyou and Trinity mountain masses. To the south, the Yolla Bolly country presents some obvious peculiarities of its own, but here, again, no adequate study has been accorded the animal life, and conclusions are therefore best deferred. To the east, the Trinity area seems satisfactorily bounded by the upper Sacramento Valley and by Shasta Valley together with the interconnectant Sisson gap, extending between mounts Shasta and Eddy.

Summary.—The collections of specimens thus far available from the Trinity region cannot be considered anywhere nearly complete; neither is there sufficient information at hand, published or otherwise, concerning the Cascades. Even with the best-worked of the faunas here concerned, that of the Sierra Nevada particularly in its Mount Shasta portion, much remains in doubt. The statistics here set forth must therefore be considered provisional. Nevertheless the general conclusions are believed closely to approximate the truth.

The Trinity region as regards its Boreal fauna is clearly far more closely allied to the Sierra-Cascade fauna than to the Humid Coast fauna. It is nearer to the Sierran fauna than to the Cascade fauna; indeed it might with propriety be included in the Sierra Nevadan faunal area, ranking merely as a subfauna.

The Trinity region contains some Sonoran "islands". The fauna of these is most closely similar to that of the Sacramento Valley; there are a few Great Basin or Modoc forms, and but scanty evidence of humid coast intrusion.

The Trinity region shows but very slight endemic individuality. It possesses but five distinguishable races or species of its own, four of which are Boreal and one Sonoran. Only one of these is well marked.

The failure of the Trinity Mountains to have developed a markedly distinct fauna from that of the Sierra Nevada, may be ascribed to three conditions: (1) Absence of extreme, that is, practically insurmountable, barriers, such as a continuous body of water, or a strip of the Sonoran zone, or a belt of excessive aridity; (2) close similarity in those features of climate included in the term humidity, for zonal identity implies similar temperature conditions at least as to mean; (3) small area as compared with that of adjacent mountain masses which, because of the greater mass of their fauna, have exerted a dominating influence in the interacting processes of invasion.

Transmitted June 29, 1914.

LITERATURE CITED

ANDERSON, M. P., and GRINNELL, J.
1903. Birds of the Siskiyou Mountains, California: a problem in distribution. Proc. Acad. Nat. Sci. Phila., 1903, 4–15.

GRINNELL, J.
1913. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., (4) 3, 265–390, pls. 15, 16.

GRINNELL, J., and SWARTH, H. S.
1913. An account of the birds and mammals of the San Jacinto area of southern California, with remarks upon the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zool., 10, 197–406, pls. 6–10.

KELLOGG, L.
1916. Report upon mammals and birds found in portions of Trinity, Siskiyou and Shasta counties, California, with description of a new *Dipodomys*. *Ibid.*, 12, 335–398, pls. 15–18.

MERRIAM, C. H.
1899. Results of a biological survey of Mount Shasta, California. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, 16, 179 pp., 5 pls., 46 figs. in text.

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THE STATUS OF THE BEAVERS OF WESTERN NORTH AMERICA, WITH A CONSIDERATION OF THE FACTORS IN THEIR SPECIATION

BY
WALTER P. TAYLOR

(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

EVOLUTIONARY CONSIDERATIONS

Problems concerning the causes and conditions of organic evolution are numerous and many of them are as yet unsolved. Even a cursory examination of zoological literature for a number of years reveals the fact that one branch of investigation has held the center of the stage for a time, only to be displaced by another and this in turn by another. This tendency toward successive popularity of different fields of work is for the most part good, of course, since it

leads to the discovery of new problems, the evolution of new theories, and the coordinated accumulation of new facts. Ill effects, however, may sometimes be realized as a result of it. A field of investigation the resources of which are by no means exhausted may be forsaken by those best fitted to prosecute researches therein on the ground that some other field looks more promising.

The studies of chorology, that is to say, of the geographical distribution of living forms, and of the relations of the living organism to its natural environment, hold, in the opinion of the writer, positions in scientific interest subordinate to those to which their abundant and practically unexplored resources would seem appropriately to assign them.

With the swing of the pendulum of scientific interest away from these fields, work on what is probably an important condition in polytypic evolution, namely, *isolation*, has practically ceased. The large place in organic evolution which may be filled by this condition has been emphasized by Wagner (1868), Dixon (1885), Romanes (1886), Gulick (1905), and Jordan (1905).

Questions arise immediately: What is isolation? Has it any importance in organic evolution? Is it not all-important? Have not the mutation and Mendelian concepts of the last few years done away with the necessity for postulating it at all as a condition of evolution? If isolation is the fictitious result of speculative induction, the sooner the concept is thrown overboard the better. If, on the other hand, it is of importance as a factor in the evolution of any group of living forms, it ought to receive broader recognition than it has heretofore.

It is the intention to present here some of the facts which seem to demand consideration, and which are drawn, not only from the study of beavers, but also from the geographical distribution and relationships of certain other families of west American (chiefly Californian) mammals. It is the hope of the writer that he may be able to emphasize: The importance of the study of isolation and certain related problems; the pertinence and indispensability of evidence from zoogeography.

DETAILS OF TREATMENT

In the preparation of this paper the inadequacy of material has been sharply felt. Still, it has been possible to get together a greater

amount of critical material representative of western beavers than has probably ever before been available to any one worker.

Ridgway's *Color Standards and Color Nomenclature* (1912) has been used as a guide to color names.

Overhair, as used in the following pages, refers to the long hairs making up the contour pelage, those which would be removed in the furrier's process of plucking. The *underfur* is the short, soft hair which covers the skin closely and which remains in the plucked skin.

For manner of taking cranial measurements see Taylor, 1911, p. 206. Special or exceptional methods of measuring are explained in the course of the paper.

Material and Acknowledgments

For the loan of material grateful acknowledgment is made to the following institutions: The United States National Museum through Mr. Richard Rathbun, Assistant Secretary, and Mr. Gerrit S. Miller, Jr., Curator, Division of Mammals; the Field Museum of Natural History through Mr. Wilfred H. Osgood, Assistant Curator of Mammalogy and Ornithology; and the United States Department of Agriculture through Mr. H. W. Henshaw, Chief of the Bureau of Biological Survey.

Considerable material representative of western beavers is contained in the collection of the Museum of Vertebrate Zoology of the University of California. The gathering of this material has been largely due to the interest of Miss Annie M. Alexander in the particular problem. The specimens from the San Joaquin River, California, were obtained directly by her from a local trapper, and those from Vancouver Island and southeastern Alaska were collected on three expeditions from the Museum made possible through means furnished by her. Altogether 86 specimens of beavers, some represented by skins and skulls, others by skulls alone or skins alone, and one by jaws only, have been available for study.

The writer is also indebted to the following persons, who have very generously given of their time and interest in assisting through helpful criticism and suggestion: Professor Charles A. Kofoid, Professor Samuel J. Holmes, Professor J. Frank Daniel, Professor John C. Merriam, Dr. Harold C. Bryant, Mr. F. H. Holden, and especially Dr. Joseph Grinnell.

Nomenclature

Three species of beavers, with altogether twelve subspecies, have been described from North America.

The American beaver was separated from the European by Kuhl (1820, p. 64) under the name of *Castor canadensis,* its type locality being Hudson Bay.

The specific name *americanus* was applied to the American beaver by F. Cuvier (1821, not seen) but this name is antedated by Kuhl's *canadensis.* Although the account on which Kuhl's name is based is fragmentary, it includes a description of the animal.

Gray (1869, p. 293) separated the beaver of the "northwest coast of America" as *Castor canadensis leucodonta.* This description was on the basis of specimens collected by Dr. Robert Brown. It is very probable that they were obtained on Vancouver Island (Osgood, 1907, p. 47).

The beaver of northern Mexico and the southern Rocky Mountain region was described by Mearns (1897, p. 502) under the name *Castor canadensis frondator,* its type locality being San Pedro River, Sonora, Mexico, near monument no. 98 of the Mexican boundary line.

A year later two more races were described by Rhoads (1898, pp. 420 and 422 respectively): *Castor canadensis carolinensis,* type locality Dan River, near Danbury, Stokes County, North Carolina; and *Castor canadensis pacificus,* type locality Lake Kichelos or Kecheelus, Cascade Mountains, Kittitas County, Washington.

The beaver of Texas was shown to be distinct by Bailey (1905, p. 122), and was described as *Castor canadensis texensis,* type locality Cummings Creek, Colorado County, Texas.

Expeditions from the Museum of Vertebrate Zoology of the University of California found beavers on several of the islands of southeastern Alaska, although Admiralty Island is the only one which is so far represented by specimens. The race found on this island was described by Heller (1909, p. 250) as *Castor canadensis phaeus,* type locality Pleasant Bay, Admiralty Island, Alaska.

The beaver inhabiting the Sacramento and San Joaquin valleys of California was recently characterized as a full species, *Castor subauratus* (Taylor, 1912, p. 167), type locality Grayson, Stanislaus County, San Joaquin River, California.

The beaver of Newfoundland, like so many others of the mammals inhabiting that island, is apparently restricted to it alone. It was

recently described by Bangs (1913, p. 513), under the name of *Castor caecator*.

Two more subspecies of *canadensis*, presenting respectively a very pale desert coloration, and a dark, rich coloration, have been described by Bailey (1913, pp. 191-193). These are *Castor canadensis mexicanus*, type locality Ruidoso Creek, six miles below Ruidoso, New Mexico, and *Castor canadensis michiganensis*, type locality Tahquamenaw River (five miles above falls), Luce County, Michigan.

The beavers of the west coast recognized in this paper are as follows:

Castor canadensis belugae, new subspecies (see p. 429), Cook Inlet region, base of Alaska Peninsula and probably Kenai Peninsula, and southward west of Rocky Mountains to central British Columbia.

Castor canadensis phaeus Heller, Admiralty Island, Alaska; probably neighboring islands and mainland.

Castor canadensis leucodonta Gray, Vancouver Island.

Castor canadensis pacificus Rhoads, probably mainland of British Columbia, Washington and Oregon; precise limits of range unknown.

Castor canadensis frondator Mearns, Colorado River drainage, and probably of broad distribution in southern Great Basin region.

Castor subauratus subauratus Taylor, Sacramento, Feather, American, and San Joaquin rivers, California.

Castor subauratus shastensis, new subspecies (see p. 433), east of Sierra Nevada Mountains, California; drainage of the Pit River.

CHANGE DUE TO AGE IN A SINGLE SPECIES (*Castor canadensis leucodonta* Gray)

Beavers secured on Vancouver Island by the expedition of the Museum of Vertebrate Zoology in 1910 represent three generations, and so make possible an outline of the changes in certain characteristics due to age.

EXTERNAL CHARACTERS

MEASUREMENTS

(See table, p. 419)

Difficulties are immediately apparent when one attempts to set down laws of change of form with age, the most important of which are that *(a)* weights and measurements of the youngest beavers are

I. EXTERNAL MEASUREMENTS* OF *Castor canadensis leucodonta* FROM VANCOUVER ISLAND, BRITISH COLUMBIA

Specimens arranged approximately in order of age from top of table to bottom
(All measurements in millimeters)

Museum number	Sex	LOCALITY	Total length	Tail vertebrae	Hind foot	Ear†	Weight in pounds	Length scaled portion of tail (dry skin)	Width scaled portion of tail (dry skin)	Number of scale-rows in broadest part of tail	Ratio tail vertebrae to total length	Ratio width scaled portion of tail to length
12109	?	Hall's Ranch, Alberni Valley	....	......	......	....	....	94.6	37.6	31	....	39.7
12110	?	Hall's Ranch, Alberni Valley	....	......	......	....	....	110.6	43.1	....	. ..	39.1
12106	♂	Hall's Ranch, Alberni Valley	....	......	......	....	....	116.0	42.3	31	. .	36.7
12105	♀	Hall's Ranch, Alberni Valley	503	162	93	24	....	124.2	39.5	34	32.2	31.8
12104	♀	Hall's Ranch, Alberni Valley	900	280	165	22	22	213	92	31	31.1	43.2
12108	♀	Hall's Ranch, Alberni Valley	967	400	170	38	25	260	98	35	41.4	37.7
12102	♂	Hall's Ranch, Alberni Valley	932	350	173	31	28	225	99	35	37.5	43.0
12103	♀	Hall's Ranch, Alberni Valley	925	350	170	25	28	225	94	34	37.8	41.8
12101	♂	Hall's Ranch, Alberni Valley	1000	340	175	31	38	237	120.9	34	34.0	51.0
12111	♂	Great Central Lake................	990	395	175	30	42	243	108.5	34	39.9	44.6
12107	♀	Hall's, Ranch, Alberni Valley	1157	450	200	33	49.5	270	124.2	33	38.9	46.0

*For method of taking measurements see Taylor, 1911, pp. 206, 207.
†Ear from crown.

lacking; *(b)* dimensions of the scaled portions of the tails were not usually taken in the field, and absolutely accurate measurement is impossible in dry skins on account of their shrinking and crinkling; *(c)* the irregularity of their arrangement makes it difficult to avoid error in counting the scale-rows transversely on the tail.

Keeping these possibly modifying factors in mind, it is believed, however, that certain general propositions may be formulated and regarded as fairly dependable:

(1) Weight and dimensions increase with age. Growth continues as in certain other mammals (for example, the gopher, *Thomomys*) practically through life.

(2) The number of scale-rows on the tail is apparently the same in adults and in juvenals, the increase in size taking place through an augmentation in measurements of the individual scales.

(3) The ratio of the length of the tail vertebrae to total length apparently increases with age (no. 12108 constitutes an apparent exception to this statement).

(4) There is evident a tendency for the tail to increase in width somewhat more rapidly than in length.

There is great individual variation in the ratio of the width of tail to length. According to the table, the maximum of this ratio is 51.0 percent, minimum 31.8, indicating a variation of 19.2 percent. The average of all the ratios is 41.3 percent. Although the animals presenting the highest ratios are adults, there is no very clear correlation between age and different proportional dimensions of tail.

Two specimens (nos. 71830, 71833, loaned by the Biological Survey), being younger than the youngest listed in the table, have ratios of 44 and 47 respectively.

Coloration and Pelage

On the whole, the coloration of the juvenals is very much like that of the adults. There is a change toward a deepening in general coloration, and a slight differentiation of color areas with increased age. In the adults there tends to be a dark area (one obtains a general impression of seal brown or a little paler) in the middle of the back, with a lightening of coloration (varying from near hazel or cinnamon-buff to chestnut) on the sides of the face, the top of the head, the nape of the neck, the shoulders and the rump. The pelage of the young is softer and fluffier than that of the adults.

No differences in relative amounts of underfur and overhair can be clearly correlated with age. No individual out of four juvenals at hand (nos. 12109, 12110, 12106, and 12105, taken June 20 to 27) has the overhair so worn as it is in certain adults (as nos. 12108 and 12107, taken June 25).

The coloration of the underfur changes little with age, varying above, in both old and young, from fuscous and fuscous-black to benzo and hair brown, and varying beneath about light drab and light cinnamon-drab. One adult specimen (no. 12101) has the underfur above an almost uniform drab.

Two very young juvenals, loaned by the Biological Survey (nos. 71830, 71833) are very similar to the juvenals mentioned above. Being younger, the hair of nos. 71830 and 71833 is noticeably shorter, softer, and fluffier. The only difference in coloration is a slightly darker general effect dorsally.

Dorsal coloration.—There is in the older animals a distinct darkening in dorsal appearance, the color varying from cinnamon to chestnut. This darkening is partly the result of darker coloration of individual hairs, and partly the result of the showing through to a greater degree of the dark underfur. The juvenals are pinkish cinnamon to cinnamon, sometimes a little darker dorsally.

The forefeet are near warm sepia or mars brown in the young, while in the older ones they have a deeper shade and exhibit something of a luster.

The hind feet of the young are near mars brown, although it is very difficult to fix the tone, while those of the adults are browner, varying from near carob brown to near hazel.

Ventral coloration.—The juvenals have more of a golden luster ventrally along the sides of the belly than the adults. The coloration mid-ventrally varies about drab in the juvenals, with a tendency to be darker in the adults. The area just anterior of the tail ventrally varies in the adult between cinnamon-brown and chestnut or bay, while in the juvenals it varies between walnut brown and cinnamon-buff.

Molt and range of individual variation.—Adequate material for the study of the molting process in beavers is lacking. It seems probable that the molt is not regional, as it is in chipmunks and gophers, but general, the hair being renewed gradually all over the body.

In some species there seems to be decided individual variation in coloration of pelage. Of the specimens from eastern Canada at hand, one (no. 4358, U. S. Nat. Mus., May 21) is in light pelage, while two (nos. 174525, 174526, U. S. Nat. Mus., Sept. 25) are in dark pelage. Among skins of *Castor canadensis phaeus* from Admiralty Island, one (no. 209, Mus. Vert. Zool., May 16) is very dark, while another (no. 210, Mus. Vert. Zool., June 1) is paler. Details of these differences appear in the tabulations of coloration in the following pages.

Tail.—The variation in measurements and proportions of tails is recorded in table I, p. 419.

Scattered hairs, which grow from between the scales, appear in the tails of the juvenals, but are generally lacking in those of the adults.

CRANIAL CHARACTERS

(See table, opp. p. 426, and fig. B, p. 424)

General Change

The skull is rounded in young animals, with frontals elevated, and interparietal region sloping. In adults it is more flattened, with frontals not elevated and interparietal region not sloping so much.

As growth continues, the comparatively undifferentiated skull of the juvenal becomes adapted to the increased strains put upon it, the sutures tend to disappear, the bones harden, processes and ridges develop greatly, and there is an increase in size.

Every bone changes somewhat in outline as the animal grows older, the most evident modifications being (*a*) loss by the frontals of their jardinier or vase-shape in outline as viewed dorsally, and their assumption of a fleur-de-lis shape, due to encroachment of temporal ridges anteriorly; (*b*) narrowing and antero-posterior extension of the interparietal, giving it, in outline as viewed dorsally, an Indian-club rather than a subrectangular shape; (*c*) change in outline of the palatine as viewed ventrally, so that instead of being nearly an equilateral triangle it is isosceles; (*d*) widening of the foramen magnum proportionally to its height.

Teeth

Milk Dentition and the Eruption of the Teeth

The dental formula of the beaver is $I\frac{1}{1}$, $C\frac{0}{0}$, $P\frac{1}{1}$, $M\frac{3}{3} \times 2 = 20$.

Fig. A. Occlusal surface of P^4, to show method of taking measurements. Approximately natural size.

Milk premolars are brachydont, usually with three well-developed roots, though in one specimen at hand there are two roots only. Tooth eruption is as follows: milk premolar 4; molar 1; molar 2; molar 3; permanent premolar 4. The order of appearance of the teeth is the same on both jaws, the corresponding upper and lower teeth appearing simultaneously.

II. MEASUREMENTS* OF TEETH OF *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA

(All measurements in millimeters)

Transverse†

Museum number	Sex	P^4	M^1	M^2	M^3	P_4	M_1	M_2	M_3	Basilar length of crania
12104	♂	5.7	5.8	5.2	5.2	4.8	5.6	5.8	5.2	99.6
12108	♀	4.7	6.2	5.8	5.4	4.8	6.2	6.2	5.5	100.6
12103	♀	5.2	5.7	5.3	5.2	5.0	5.9	5.8	5.3	103.9
12102	♂	5.2	6.0	5.8	5.4	5.2	6.2	6.4	5.7	105.8
12111	♂	7.7	7.4	6.7	6.0	6.7	7.7	7.4	6.2	110.9
12101	♂	8.4	7.7	6.9	6.1	7.0	7.5	7.0	6.2	111.9
12107	♀	7.7	7.4	6.5	6.2	6.8	7.6	7.0	6.2	122.6

Longitudinal†

Museum number	Sex	P^4	M^1	M^2	M^3	P_4	M_1	M_2	M_3	Basilar length of crania
12104	♂	5.5	6.1	5.6	5.3	6.1	7.0	7.2	6.8	99.6
12108	♀	5.7	5.9	5.5	5.3	6.1	7.4	7.1	6.8	100.6
12103	♀	5.4	6.0	5.4	5.2	6.1	6.7	6.7	6.8	103.9
12102	♂	5.6	6.0	5.7	5.3	6.6	6.9	7.0	7.2	105.8
12111	♂	7.4	6.4	6.3	6.1	8.9	7.6	7.9	7.5	110.9
12101	♂	7.6	6.5	6.7	6.5	9.0	8.0	8.1	7.3	111.9
12107	♀	8.2	6.9	6.2	5.9	9.0	7.5	7.5	7.6	122.6

*Each measurement is taken three times and the results averaged to give the measurement here entered.

†See figure A.

Some Characteristics of the Permanent Dentition

The permanent dental armature exemplifies a high degree of hypsodonty. The oldest crania available to the writer have the pulp-cavities of the cheek-teeth almost completely closed. In order to ascertain whether there is a pronounced change in size of teeth with age, all the cheek-teeth on the left-hand side, above and below, of seven available skulls from Vancouver Island, were measured. The skulls themselves belonged to animals of different ages. In nos. 12104,

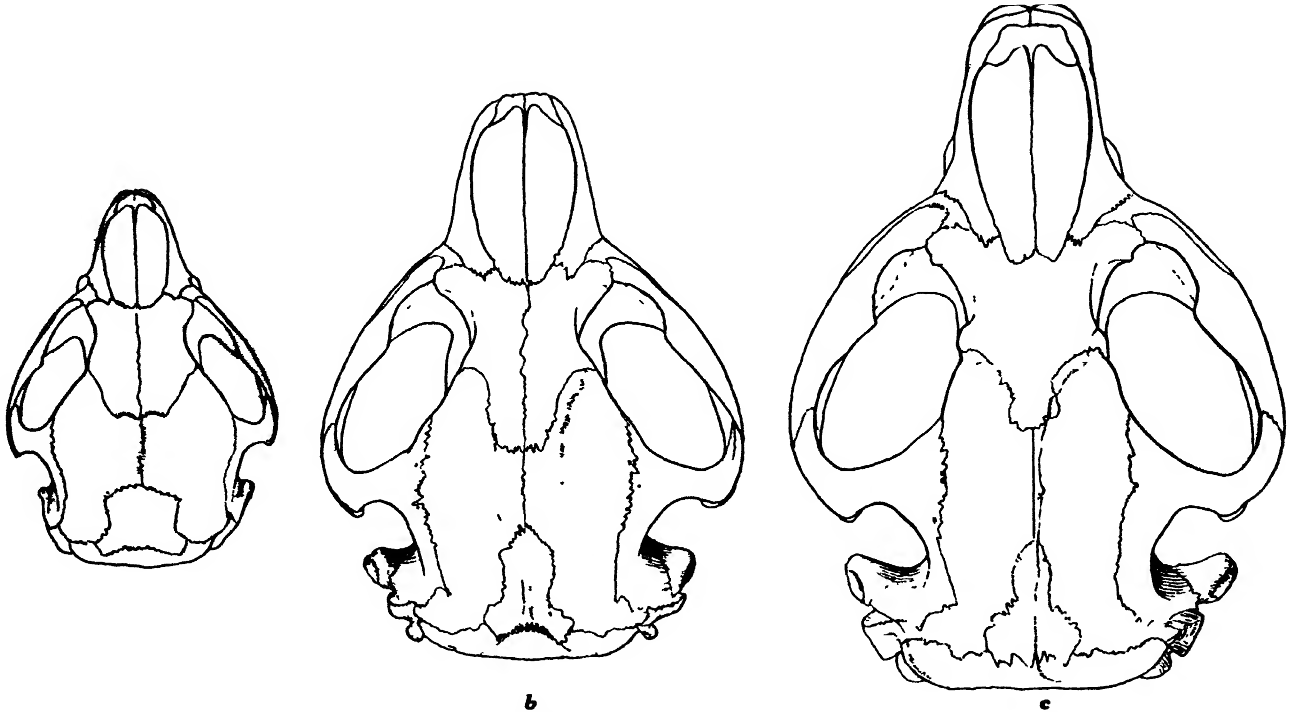


Fig. B. Outline drawings to show some of the changes occurring with age in *Castor canadensis leucodonta*. Figures approximately two-thirds natural size.

a. Young animal; no. 12106, ♂, Alberni, Vancouver Island, British Columbia.

b. Older animal; no. 12102, ♂, Alberni, Vancouver Island, British Columbia.

c. Old adult beaver; no. 12107, ♀, Alberni, Vancouver Island, British Columbia.

12108, and 12103 the permanent premolar has hardly become functional. No. 12107 is the skull of a comparatively old adult, as shown by its dimensions and degree of development. To reduce the margin of error, each dimension was carefully taken three times, and the results averaged, in case they did not exactly agree (see table II).

It is apparent, from the data of the table of measurements, that all the cheek-teeth first increase in size with age, then undergo a slight absolute or proportional decrease. It should be noted that the initial increase is of greater magnitude than is the later decrease. The tooth pierces the gum, increases in size up to a certain point, then decreases *slightly*. Since the oldest skulls at hand, without exception, have the longest maxillary tooth-rows, the decrease in tooth dimension late in life is not sufficient to affect the validity of the "length of the maxillary tooth-row" as a comparative measurement.

The table of measurements indicates that there are no important differences in the relation of the antero-posterior to the transverse diameter of the teeth in crania of different ages. One notes that the relation of the longitudinal or antero-posterior diameter of the teeth to the transverse is more variable in the superior teeth than in the inferior, in which latter the antero-posterior diameter exceeds the transverse in nearly all cases.

A number of possibly significant conclusions are derivable from the tables of measurements of the teeth of beavers of different species (tables II and IV):

(1) All the superior molars measured have the transverse diameter equal to or exceeding the antero-posterior, except in the following cases: in no. 12104, Vancouver Island (M^1, M^2, M^3); no. 12103, Vancouver Island (M^1, M^2); no. 12111, Vancouver Island (M^3); no. 12101, Vancouver Island (M^3); no. 3672, Skagit River, Washington (M^3); in nos. 209 and 210, Admiralty Island (M^2, M^3).

(2) All the superior premolars measured have the antero-posterior diameters equal to or exceeding the transverse, except in the following cases: nos. 12101, 12104, 12111, Vancouver Island; nos. 174525, 174526, New Brunswick.

(3) Inferior molars in *leucodonta* have the antero-posterior diameter greater than the transverse (except M_1 in nos. 12111 and 12107, Vancouver Island).

(4) All the inferior premolars measured have the antero-posterior diameter greater than the transverse.

The Dental Armature as a Cutting and Grinding Agency

The work of the beaver, as exemplified in the cutting of materials for lodges and dams, serves to illustrate the efficiency of the incisors as cutting agents. The beaver's incisor is said to have been the hardest substance except flint known and used as a cutting tool by certain tribes of North American Indians. That the grinding portions of the beaver's dental armature are no less efficient to perform the function required of them is evident when it is considered that bark, a substance requiring very powerful mastication, is the beaver's principal food. Counting from front to back there are about 40 transverse cutting blades on each maxillary tooth-row, making 80 cutting blades for the upper teeth. A similar number obtains for the lower teeth. Only one side at a time can be opposed in the process of mastication, so that 40 blades above are brought against 40 blades below in the course of one chewing movement. If there is enough lateral motion during this movement, however, all 80 of the blades of the upper teeth may be ground against the 80 blades of the lower teeth. In the former case 80 cuts, in the latter 160, would be given to the mouthful of material. In case the beaver makes 100 chewing movements a minute, the number of cuts for that period would be in the former case 8000, in the latter 16,000.

Unfortunately, the writer has never been privileged to ascertain from watching the animal in life what the characteristic jaw movements are, nor have references to the matter been found in the literature examined. On the basis of the arrangement of the series of teeth with reference to one another it may be concluded, however, that there is an antero-posterior movement of probably 15 to 20 millimeters magnitude. That there is lateral motion is equally certain, although it must be much less than the antero-posterior. Eight millimeters appears to be about the maximum sidewise movement possible.

Parallelism in *Castor* and *Erethizon*

The general resemblance of the enamel pattern of the cheek-teeth obtaining between the genera *Castor* and *Erethizon* has been remarked by former workers. Another character, of interest in this connection, is the condition of the palato-maxillary region, which is rounded instead of plane in both genera. Authorities on classification agree in referring the beavers to the sciuromorph section of the Rodentia,

while the porcupine belongs to the section Hystricomorpha. If the above-mentioned resemblances are not due to inheritance from a common ancestor, and the bulk of evidence would seem to indicate that they are not, they illustrate a noteworthy case of parallel development in these widely different sections of the Rodentia. It is doubtless something more than coincidence in this connection that the beaver and the porcupine are bark-feeders. The rounded instead of plane conformation of the palato-maxillary region, and the similar complication of the enamel pattern of the cheek-teeth, appear to be direct adaptations: the first to the stripping of bark from twigs and branches; the second to its effective mastication.

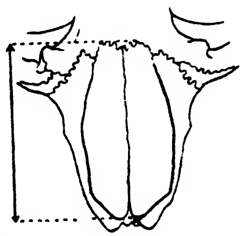


Fig. C. Rostrum, dorsal aspect, to show method of taking measurement "Length of nasals". About one-half natural size.

Dimensions of Crania

From the table of cranial characters (opp. p. 426) it appears that with age: (*a*) nearly every bone increases in size, each outside skull dimension becoming greater; (*b*) the ratio of the length of the interparietal to basilar length decreases (though no. 12101 departs rather widely from this rule); (*c*) the mastoid width increases at practically the same rate as does the basilar length, although giving evidence of a slight tendency to increase less rapidly.

Temporal Ridges

The degree of approximation of the temporal ridges is in general indicative of age, although the rate of approximation may vary in different forms. In *leucodonta* the temporal ridges first come together posteriorly, then continuously in an anterior direction. In the oldest skulls the ridges form a sagittal crest, narrow posteriorly, broader anteriorly, which extends to within 25 mm. of a line drawn at right angles to the antero-posterior axis of the skull at the narrowest part of the interorbital constriction.

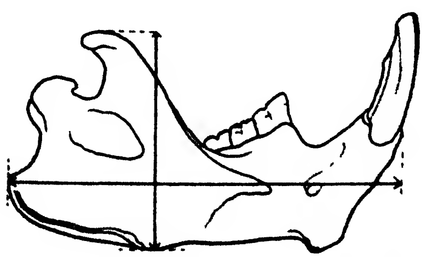


Fig. D. Lateral view of mandible, to show method of taking measurements. About one-half natural size.

Bailey (1905, p. 122) refers

IV. MEASUREMENTS* OF SUPERIOR CHEEK TEETH OF CERTAIN AMERICAN SPECIES OF BEAVERS

(All measurements in millimeters)

Museum number	Sex	Subspecies	Length†				Width†			
			P^4	M^1	M^2	M^3	P^4	M^1	M^2	M^3
12654	♀	Castor subauratus subauratus	9.3	7.1	6.5	6.6	9.1	7.8	7.5	7.6
8988	♀	Castor subauratus subauratus	8.4	6.6	6.1	6.1	8.2	7.7	7.0	6.9
16383	♂	Castor subauratus subauratus	8.8	6.9	6.1	6.2	8.5	7.8	7.5	7.2
3672	?	Castor canadensis pacificus	9.4	7.6	7.1	7.3	9.1	8.3	7.7	6.9
12107	♀	Castor canadensis leucodonta	8.2	6.9	6.2	5.9	7.7	7.4	6.5	6.2
12101	♂	Castor canadensis leucodonta	7.6	6.5	6.7	6.5	8.4	7.7	6.9	6.1
60354	♂	Castor canadensis frondator	9.8	6.9	6.4	6.1	8.3	7.6	7.3	6.3
35946	♀	Castor canadensis frondator	8.1	6.3	6.0	5.8	7.8	7.1	6.5	5.9
4225	♂	Castor canadensis belugae	9.2	7.2	6.7	6.3	9.1	8.7	8.1	6.6
4220	♂	Castor canadensis belugae	8.7	7.0	6.4	6.1	8.6	7.9	7.6	6.9
4347	♂	Castor canadensis belugae	7.9	6.3	6.1	6.1	7.9	7.9	7.2	6.5
210	♂	Castor canadensis phaeus	8.8	7.1	6.5	6.4	7.9	7.9	6.6	6.1
209	♂	Castor canadensis phaeus	8.7	7.2	6.9	6.5	7.8	7.3	6.9	6.2
174525	♂	Castor canadensis canadensis	7.7	6.6	6.0	6.0	7.8	6.9	6.4	6.0
174526	♀	Castor canadensis canadensis	7.6	6.7	6.4	6.5	8.5	7.5	7.0	6.7

*In respect to these dimensions three possible sources of error should be noted: (1) The skulls may not be of precisely similar age; (2) in teeth of the shape of beaver's teeth it is hardly possible to be certain that a given measurement is taken always in precisely the same manner; (3) the teeth in skulls of comparable age may not represent exactly the same stage of wear. These considerations would seem to indicate that only the larger dimensional differences should be regarded as significant. The error has been avoided so far as possible (*a*) through selection of skulls of as nearly the same age as were available, (*b*) through one person taking all the measurements, and so far as possible at one sitting, and (*c*) through taking each measurement three times and averaging the results, where these did not agree. Errors in one direction are, moreover, likely to be balanced by those in the opposite direction.

†See figure A.

to the lyrate condition of temporal ridges as a character of *Castor canadensis texensis.* While it is probable that the character is of subspecific value in the Texan form of beaver, the fact that the material on which the description was based was exceedingly limited in amount emphasizes the alternative possibility that it is a character due to age only. Significant in this connection is the further fact that in the following forms the character is one the condition of which apparently depends solely on age: *Castor fiber, Castor canadensis phaeus, Castor canadensis belugae, Castor canadensis canadensis, Castor canadensis leucodonta,* and *Castor canadensis frondator.*

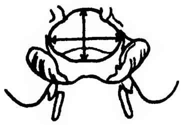


Fig. E. Outline of foramen magnum, to show method of taking measurements. About one-half natural size.

DESCRIPTION OF A NEW SUBSPECIES OF BEAVER FROM THE COOK INLET REGION, ALASKA

In the labor of allocation of specimens and determination of their status it soon became apparent that the skulls from Cook Inlet were somewhat different from those of any other race of beaver. Examination of additional comparable material confirms the differences first observed.

Castor canadensis belugae, new subspecies

Type.—Skull only, ♂ youngish adult, no. 4224, Mus. Vert. Zool.; Beluga River, Cook Inlet region, Alaska; "1907"; collected by Jacob Seminoff; orig. no. 2.

Diagnostic characters.—Perhaps nearest *Castor canadensis leucodonta* Gray, but crania immediately distinguishable through the narrower blades of the hamular processes of the pterygoids in *Castor canadensis belugae;* bony ridge laterally on rostrum less strongly developed in *belugae* than in *leucodonta; belugae* with tendency for maxillary tooth-row, and ratio of maxillary tooth-row to basilar length, to be greater.

Belugae is similar to *Castor canadensis canadensis* Kuhl, but with nasals of different outline, the lateral swelling being more posteriorly placed; maxillary tooth-row and ratio of maxillary tooth-row to basilar length tending to be greater.

External characters.—Only one skin of the new form (no. 4347,

Mus. Vert. Zool.) is at hand. For comparison of this with *Castor canadensis leucodonta* see below. A comparison with *Castor canadensis canadensis* is given in table opposite p. 432.

Range.—It is impossible at this time to define precisely the limits of range of *Castor canadensis belugae.* Specimens from the following localities have been examined: Beluga River (tributary to Cook Inlet from the north); Nenilchuk (sometimes spelled Ninilchik [Baker, 1906, p. 463], a village on eastern shore of Cook Inlet, south of the mouth of the Kasilof River); Kasiliff (probably Kasilof, a fishing village at the mouth of Kasilof River, Cook Inlet, according to Baker, 1906, p. 353); Snug Harbor, Alaska Peninsula (probably Snug Harbor on the western shore of Cook Inlet, near Iliamna Peak [Baker, 1906, p. 586]); and the general vicinity of Stuart Lake, British Columbia.

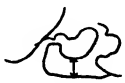


Fig. F. Outline of hamular process, showing method of taking measurement. About one-half natural size.

It is probable that the form occupies territory on the mainland from central British Columbia on the south to the Alaskan Mountains on the north. The main chain of the Rocky Mountains doubtless bounds its range on the east, and the ocean, or possibly certain coast mountains on the west.

This region is much interrupted topographically and it is not unlikely that adequate material would show considerable local differentiation, possibly the presence of well-marked subspecies, within its boundaries. Militating against this suggestion, however, is the observed similarity of specimens from such widely separated points as the Cook Inlet region, Alaska, and Stuart Lake, British Columbia.

Remarks

Comparison With *Castor canadensis leucodonta* Gray

The new subspecies, *belugae,* is perhaps nearest *leucodonta,* of which examples from Vancouver Island are at hand, although it is intermediate between that form and *canadensis* from eastern Canada. Crania can be distinguished from *leucodonta* by the narrower blades of the hamular processes of the pterygoids in *belugae* (see fig. F, above); by the ridge laterally on the rostrum less strongly developed than in *leucodonta;* by the tendency in *belugae* for maxillary tooth-row to be longer, shown also in ratio of maxillary tooth-row to basilar length.

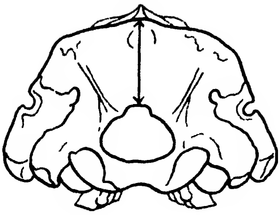


Fig. G. Outline of posterior portion of cranium of beaver, to illustrate method of measuring dorsal outline foramen magnum to inion, or most dorsal point on outline of foramen magnum to occipital crest on median line. About one-half natural size.

Belugae, on the basis of the table of measurements, has longer antero-posterior diameter of P^4 than in *leucodonta*, although specimens nos. 4347 from Cook Inlet and 12101 from Vancouver Island are nearly the same in this respect (see table IV, p. 428). *Belugae* generally has broader teeth transversely than in *leucodonta* (P^4 in specimen no. 12101, from Vancouver Island exceeds P^4 in no. 4347, from Cook Inlet).

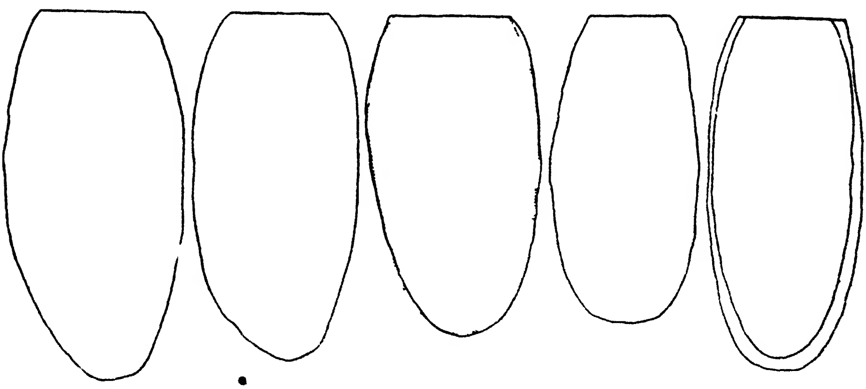


Fig. H. Outline drawings of tails of different races of western beavers. Approximately one-sixth natural size.

a. *Castor subauratus subauratus*, ♀, no. 12654, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

b. *Castor canadensis leucodonta*, ♀, no. 12107, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

c. *Castor canadensis phaeus;* solid line, no. 210, Mus. Vert. Zool., ♀, Hasselborg Lake, Admiralty Island, Alaska; dotted line, no. 209, Mus. Vert. Zool., ♂, Pleasant Bay, Admiralty Island, Alaska.

d. *Castor canadensis frondator*, ♀, no. 20751, U. S. Nat. Mus.; San Pedro River, Sonora, Mexico.

e. *Castor canadensis canadensis;* inner line, no. 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick; outer line, no. 174525 ♂, U. S. Nat. Mus., same locality.

Comparable skins of the two subspecies are distinguishable as follows: the single skin of *belugae* with both overhair and underfur thicker than in *leucodonta; belugae* paler in coloration than average of *leucodonta,* particularly about base of tail, which is near cinnamon-buff in *belugae,* varying from near hair brown to a shade between chocolate and bay in *leucodonta;* tails are similar in general outline.

COMPARISON WITH *Castor canadensis canadensis* KUHL

Skulls of *belugae* comparable with *canadensis* as regards age have outline of nasals different; maxillary tooth-row longer in comparable crania; ratio of the maxillary tooth-row to basilar length averaging greater. *Belugae,* according to the table of measurements, has teeth tending to be broader and longer than in *canadensis.* A detailed comparison of external characters of the Cook Inlet race and *canadensis* will be found in table VII, opposite.

The following table illustrates differences in tail outline:

VI. MEASUREMENTS AND RATIOS OF SCALED PORTIONS OF TAILS

All measurements in millimeters, and taken from dry skins

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor canadensis belugae......	4347	245	115	47.0
Castor canadensis canadensis..	4358	223	92	41.1
Castor canadensis canadensis..	174525	265	116	43.4
Castor canadensis canadensis..	174526	260	108	41.3

The tails of 4347 and 4358 were considerably crinkled and dried hard, so that their measurements are less dependable than those of the others.

COMPARISON WITH *Castor canadensis phaeus* HELLER

Separated from *Castor canadensis phaeus* Heller, inhabiting Admiralty and probably neighboring Alaskan islands, on following characters: *belugae* with broader interorbital constriction than in *phaeus;* nasals of different outline, these bones not tapering caudad as they do in *phaeus;* nasals with lesser degree of extension back of a line joining the points of the antorbital tubercles. While individual specimens show intergradation in one or two of these characters, as might be anticipated, it is true that in the series at hand every specimen is clearly separable. Externally *belugae* is dis-

VII. COMPARISON OF EXTERNAL CHARACTERS OF *Castor canadensis phaeu*
TAYLOR, FROM COOK INLET REGION, ALASKA, AND WI

Points of Comparison	*Castor canadensis phaeus* (two examples)
General coloration	No. 210 similar in coloration to no. 4847 from Cook Inlet; no. 209 much darker; all the other specimens of *phaeus* similar to no. 209.
Dorsal overhair	No. 210 with tips of dorsal overhair between cinnamon and sayal brown; no. 209 varying about seal brown.
Dorsal underfur	No. 210 benzo brown to bone brown; no. 209 light seal brown to benzo brown.
Overhair of sides	No. 210 with dark coloration of dorsal overhair grading into the verona brown or warm sepia of the ventral overhair with slight intermediate lightening; no. 209 cinnamon and sayal brown of dorsal overhair grading toward the verona brown of the ventral overhair.
Top of head	No. 210 orange-cinnamon; no. 209 mikado brown.
Sides of face	Nos. 210 and 209 cream-buff grading toward honey yellow.
Base of tail above	No. 210 near bister, becoming paler anteriorly; no. 209 near warm sepia.
Forefeet	No. 210 near cinnamon-drab; no. 209 cinnamon-drab to benzo brown.
Hind feet	Lighter than in *canadensis:* No. 210 near mars brown, burnt umber or Hay's brown; no. 209 deep brownish drab.
Ventral overhair	Nos. 210 and 209 varying about verona brown and warm sepia.
Throat band	No. 210 varying about cinnamon-buff, slightly paler dorsally, slightly darker ventrally; no. 209, scarcely indicated pinkish buff in coloration.
Base of tail beneath	No. 210 hazel to chestnut; no. 209 varying about verona brown, warm sepia and mars brown.
Ventral underfur	No. 210 shaft of hair pale drab-gray, terminally approaching drab, general impression of light drab given; no. 209 similar, but general impression nearer light cinnamon-drab.
Tail	Broader than in *canadensis*.

The outline of the nasals is distinctive. In *Castor subauratus shastensis* the nasals do not taper so regularly or rapidly posteriorly as in *Castor subauratus subauratus*. The lateral nasal outline is, in *shastensis*, invaded by the postero-medial portion of backward-extending tongue of the premaxilla. Consequently there is formed a "bay" in the lateral outline of the nasals posteriorly, which is lacking in *subauratus*. In one or two specimens of the latter there is a slight indication of such a relation, but the diagnostic value of the character as given, both in adult and young specimens of both species, holds in available material. The nasals tend to maintain their full breadth farther posteriorly in *shastensis* than in *subauratus*. The temporal ridges tend to form a distinct sagittal crest posteriorly and to show a higher degree of approximation anteriorly in *shastensis*, in specimens of the age which in *subauratus* exhibits a weak development of the crest posteriorly and a lyrate arrangement of the ridges anteriorly. Not only is there developed a distinct sagittal crest, but also a much more distinct knob dorsally on the crest located about 29 millimeters anterior of the posterior border of the lambdoidal ridge. The size of the cranium and the condition of certain sutures, whether open or closed, constitute the chief bases for age determination. Specimen no. 51477 of *shastensis*, which is considerably younger than specimen no. 12654 of *subauratus*, presents the same general arrangement of the temporal ridges. *Shastensis* no. 50979, which is certainly not older than specimen no. 12654 of *subauratus*, exhibits the characteristically distinct sagittal crest posteriorly and the higher degree of approximation anteriorly. The lambdoidal ridge is also more strongly developed in crania of nearly equal age. The use of these characters as subspecifically differentiatory might be unjustified without a mass of material, were they not correlated with others; for they undergo marked modification with age within the same subspecies. However, a different degree of development for the same age undoubtedly can be relied upon. In this case, although the available material is not sufficient to prove, for instance, that very old examples of *subauratus* would not show the distinct sagittal crest posteriorly, the higher degree of approximation of temporal ridges anteriorly, and the more strongly developed lambdoidal ridge, it does suffice to indicate a difference at least in rate of progress, and this difference is valid as a subspecific character.

The interorbital constriction is broader in *shastensis*. This meas-

urement in *shastensis* no. 50977 exceeds that in *subauratus* no. 12668, which has the same basilar length, by 8.9 percent. The difference holds throughout the series in specimens of comparable age.

The fronto-maxillary suture, situated dorsally on skull between backward-extending tongue of premaxilla and malar, is longer in *shastensis* than in *subauratus*. This holds for all specimens, regardless of age (see tables of measurements, pp. 436 and 449.)

The interparietal is somewhat broader in all specimens of *shastensis,* old and young, than it is in any specimen of *subauratus.*

Remarks.—The new subspecies, while clearly marked off from the beaver of the San Joaquin Valley by a number of valid cranial characters, nevertheless finds in the golden beaver its closest ally. This is shown by the facts that: (1) It is nearly identical with *Castor subauratus subauratus* in many cranial dimensions; (2) its foramen magnum shows the same general proportions; (3) its process medially in the interpterygoid fossa is nearly identical with that in *subauratus*, being different in form from that of any other west American beaver.

Cassel, Shasta County, California, the type locality of the new form, is situated on Hat Creek, a tributary of the Pit River, which is in turn a tributary of the Sacramento River. The two forms, *Castor subauratus subauratus* and *Castor subauratus shastensis,* are found in the same hydrographic basin, namely that draining into San Francisco Bay. It should be noted, however, that the type locality of the Shasta beaver is on the eastern slope of the main chain of the Sierra Nevada Mountains. The surrounding region is characterized by environmental conditions probably much more typical of the Great Basin faunal area than of those of the Sacramento Valley. It is entirely possible, if not probable, that the Pit River Narrows at present constitute a barrier not regularly crossed by beavers. The limits of the range of *Castor subauratus shastensis* are yet to be defined. There would seem to be a possibility that the beaver of the Great Basin will be found to be referable to it.

Material.—Five specimens, skulls only, all loaned to the writer by the authorities in charge of the Biological Survey mammal collection, United States National Museum: Cassel, Hat Creek, Pit River, Shasta County, California (nos. 50976–50979, 51477).

VIII. CRANIAL MEASUREMENTS* OF *Castor subauratus shastensis*, FROM CASSEL, SHASTA COUNTY, CALIFORNIA

Specimens arranged approximately in order of age from top of table to bottom

(All measurements in millimeters)

Museum number	Sex	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Length of fronto-maxillary suture†	Greatest length of mandible; angle to anterior surface of alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio height of foramen magnum to basilar length
50977	♂	107.0	80.1	55.7	24.4	36.2	20.5	25.8	12.7	19.4	8.0	88.5	50.5	19.1	24.1	11.9
50976	?	95.5	78.8	53.1	24.4	34.8	21.8	26.3	12.0	18.1	7.0	86.4	49.9	22.8	27.5	12.6
51477	♂	121.7	98.3	70.5	29.7	48.3	26.2	33.4	13.6	20.6	7.3	107.1	63.1	21.5	27.4	11.2
50979	♀	122.8	99.6	69.3	30.1	49.2	27.7	33.0	11.5	19.1	6.1	106.5	65.7	22.6	26.9	9.4
50978	♂	128.0	104.8	70.7	30.5	50.6	29.1	35.2	11.1	19.0	7.9	112.6	67.1	22.7	27.5	8.7

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of present paper.

†Length of fronto-maxillary suture: taken in region of anterior root of zygomatic arch; fit one point of dividers into point of meeting of frontal, premaxilla, and maxilla; follow suture between maxilla and frontal laterad; adjust the other point of dividers at first point where maxilla touches jugal.

Comparisons of Certain American Beavers

CASTOR CANADENSIS PHAEUS HELLER, FROM ADMIRALTY ISLAND, ALASKA

Material

Six specimens of *Castor canadensis phaeus*, skins with skulls, all in collection of Museum of Vertebrate Zoology: Hasselborg Lake, Admiralty Island, Alaska, 4 (nos. 129, 185, 210, 211); Mole Harbor, Admiralty Island, Alaska, 1 (no. 128); Pleasant Bay, Admiralty Island, Alaska, 1 (no. 209).

Three specimens of *Castor canadensis canadensis*, all from collection of Smithsonian Institution, United States National Museum: Nepisiquit River, New Brunswick, 2 (nos. 174525, 174526, skins with skulls); Moose River, Ontario, 1 (no. 4358, skin with cranium inside).

Comparison With *Castor canadensis canadensis* Kuhl, from Eastern Canada

General external characters.—Specimens compared: *Castor canadensis phaeus*, nos. 128 ♂, 129 ♂, 185 ♂, 209 ♂, 210 ♂, and 211 ♂, Mus. Vert. Zool., from three localities on Admiralty Island, Alaska, May 16 to June 1, 1907; and *Castor canadensis canadensis*, no. 4358 ♂, May 21, 1860, and nos. 174525 ♂, 174526 ♀, September 25, 1911; all U. S. National Museum coll. from eastern Canada.

In coloration the Admiralty Island skins as a series resemble the two specimens from New Brunswick, although the type of the Admiralty Island race (no. 209) is darker than either. No. 210 is a lighter example than the rest of the series of *phaeus*, with more cinnamon to sayal brown coloration dorsally. *Canadensis* no. 4358 is paler than the other specimens representing the same subspecies (nos. 174525, 174526).

The ratio of width of tail to its length in the two examples of *phaeus* (nos. 209, 210) is greater, as shown below, even than it is in the specimen of *frondator* at hand (no. 20751, U. S. Nat. Mus.), attaining 54.1 percent in no. 209. The widest part of the tail, however, is located more proximally in *phaeus* than it is in *frondator*.

For comparison of external characters, see table VII, opposite p. 432.

IX. MEASUREMENTS AND RATIOS OF SCALED PORTIONS OF TAILS

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. phaeus	209	240	130	54.1
Castor c. phaeus	210	248	132	53.2
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	4358	223	92	41.1

General cranial characters.—(See table of measurements, opposite.) Crania compared: *Castor canadensis phaeus,* nos. 209 ♂, and 210 ♂, Mus. Vert. Zool., from Admiralty Island; and *Castor canadensis canadensis,* nos. 174525 ♂, 174526 ♀, U. S. Nat. Mus., from New Brunswick.

Interorbital constriction decidedly narrower in *phaeus.* Nasals in *phaeus* longer and narrower. Foramen magnum broader, the difference amounting to 13 and nearly 15 percent respectively in nos. 210 and 209, percentage taken on the basis of the average width in *canadensis.* Maxillary tooth-row longer in *phaeus,* consequently ratio of this measurement to basilar length greater. Teeth in *phaeus* with a tendency to be longer than in comparable skulls of *canadensis.*

Process in middle of interpterygoid fossa shorter in *phaeus.* Hamular processes of pterygoid (see fig. F, p. 430) broader-bladed in *phaeus* (no. 209, 4.1 mm.; 210, 4.1; no. 174525, 3.5; 174526, 3.1).

Chief points of difference: Narrower interorbital constriction (in *phaeus*), nasals of different length and outline, broader foramen magnum, longer maxillary tooth-row, longer teeth.

COMPARISON WITH *Castor canadensis belugae* TAYLOR, FROM THE COOK INLET REGION

General external characters.—Specimens compared: *Castor canadensis phaeus,* nos. 128 ♂, 129 ♂, 185 ♂, 209 ♂, 210 ♂, and 211 ♂, Mus. Vert. Zool., from three localities on Admiralty Island, Alaska; *Castor canadensis belugae,* no. 4347 ♂, Mus. Vert. Zool., Snug Harbor, Alaska Peninsula. The specimens of *phaeus* were collected, as above stated, between May 16 and June 1. The single skin of *belugae* was secured June 14, 1904.

Specimens nos. 4347 and 210 are similar in coloration, the former being slightly paler. No. 209 is much darker than either, the rest of the series from Admiralty being nearest 209.

XI. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor canadensis phaeus	209	240	130	54.1
Castor canadensis phaeus	210	248	132	53.2
Castor canadensis belugae	4347	245	115	47.0

General cranial characters.—Crania compared: *Castor canadensis belugae*, nos. 4219-4233, 4347, Mus. Vert. Zool., all from the Cook Inlet region, Alaska; *Castor canadensis phaeus*, nos. 209 ♂, 210 ♂, Mus. Vert. Zool., from Admiralty Island. Specimens 209 and 210 from Admiralty Island, and specimens 4220, 4225 and 4347 from Cook Inlet comparable as to age.

Skulls of *phaeus* slightly smaller than the average of those of *belugae*. Interorbital constriction narrower in *phaeus* than in eighteen of the twenty-two specimens of *belugae* of all ages figured. Nasals longer, more tapering posteriorly. Sharp process medially in interpterygoid fossa reduced in *phaeus*. Foramen magnum averaging broader in *phaeus*. Vertical diameter of foramen magnum in no. 209 exceeding that in any specimen from Cook Inlet, but itself exceeded by no. 77150 from Stuart Lake, British Columbia. Teeth narrower in *phaeus*, proportionally to their length. Maxillary tooth-row averaging longer, consequently ratio of maxillary tooth-row to basilar length greater in *phaeus*. No. 4233, the youngest cranium from Cook Inlet, furnishes the single exception to this rule. In this specimen the ratio of maxillary tooth-row to basilar length is greater than in no. 210. Coronoid process of mandible lighter in *phaeus*. Lateral ridge on rostrum larger in *phaeus*. Hamular blades (see fig. F, p. 430) broader (no. 210, 4.1 mm.; 209, 4.1. No. 4347, 2.5; 4225, 2.5; 4224, 3.1). Distance from most dorsal point on outline of foramen magnum to inion less (see fig. G, p. 431; no. 210, 19.4 mm.; 209, 17.1. No. 4347, 20.5 mm.; 4225, 22.4; 4224, 22.7).

CASTOR CANADENSIS LEUCODONTA GRAY, FROM VANCOUVER ISLAND, BRITISH COLUMBIA

MATERIAL

Sixteen specimens, skins with skulls, and skulls only, partly from the Museum of Vertebrate Zoology and partly from the United States National Museum, Biological Survey collection: Hall's Ranch, Alberni Valley, Vancouver Island, British Columbia, 10 (nos. 12101–12110, skins with skulls, Mus. Vert. Zool.); Great Central Lake, Vancouver Island, British Columbia, 1 (no. 12111, skin with skull, Mus. Vert. Zool.); San Josef River Valley, Vancouver Island, British Columbia, 5 (nos. 140569–140573, skulls only, U. S. Nat. Mus., Biol. Surv. coll).

COMPARISON WITH *Castor canadensis canadensis* KUHL, FROM EASTERN CANADA, AND *Castor canadensis phaeus* HELLER, FROM ADMIRALTY ISLAND

General external characters.—Specimens compared: *Castor canadensis leucodonta,* nos. 12101–12111, Mus. Vert. Zool., all but the last (which is from Great Central Lake, Vancouver Island) are from Alberni, Vancouver Island, British Columbia, June 11–27, August 25, 1910; *Castor canadensis canadensis,* nos. 4358 ♂, U. S. Nat. Mus., Moose River, Ontario, Hudson Bay region, May 21, 1860; nos. 174525 ♂, and 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick, Sept. 25, 1911; *Castor canadensis phaeus,* no. 128 ♂, Mole Harbor; nos. 129 ♂, 185 ♂, 210 ♂, 211 ♂, Hasselborg Lake; no. 209 ♂, Pleasant Bay; all Admiralty Island, Alaska, in Mus. Vert. Zool.

A specimen of *leucodonta* taken in August (no. 12111) is very similar in general coloration to the September examples of *canadensis* from New Brunswick. The resemblance in coloration of the hair dorsally is close. Coloration beneath different, varying about hair brown in *leucodonta,* near bone brown, dark grayish brown, dark vinaceous-drab or natal brown in *canadensis.* The difference in ventral coloration is more marked between no. 12111 and no. 174525, which is darker, than between no. 12111 and no. 174526, which is paler. The Vancouver Island series is not comparable with the Moose River example of *canadensis* (no. 4358). The overhair of the latter beneath is darker than in *leucodonta,* while the underfur beneath is paler. The fact that there has been much fading, however, renders comparisons taking account of no. 4358 of dubious value.

In general, the table of comparisons (see table XII, opposite p. 440) shows *leucodonta* to be paler than *phaeus.*

Difference in amount of hair is marked. The pelage is lighter weight in *leucodonta* than it is in either *phaeus* or *canadensis.*

XIII. Measurements and Ratios of Scalded Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. leucodonta	12101	237	120	51.0
Castor c. leucodonta	12111	243	108	44.6
Castor c. leucodonta	12107	270	124	46.0
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	4358	223	92	41.1
Castor c. phaeus	209	240	130	54.1
Castor c. phaeus	210	248	132	53.2

General cranial characters.—Crania compared (being of approximately same age): nos. 12101 ♂, 12107 ♀, 12111 ♂, Mus. Vert. Zool., from Vancouver Island; nos. 174525 ♂, 174526 ♀, U. S. Nat. Mus., from New Brunswick; nos. 209 ♂, 210 ♂, Mus. Vert. Zool., from Admiralty Island.

Leucondota (see tables of measurements, opp. pp. 426 and 438) is separated from *canadensis* by the following characters: External outline of nasals different, tending to be more parallel in *leucodonta* than in *canadensis,* in which there is a dilation in the outline anteriorly; foramen magnum slightly broader in *leucodonta;* hamular processes (see fig. F, p. 430) definitely broader bladed in *leucodonta* (no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8. No. 174525, 3.5; 174526, 3.1).

Distance between most dorsal point on curve of foramen magnum and point of junction of lambdoidal ridge and sagittal crest (inion, see fig. G, p. 431) greater in the eastern subspecies, as shown by the following figures:

XIV. Measurements, Foramen Magnum to Inion

Measurements in millimeters

Specimen number	Basilar length of Hensel	Distance foramen magnum to inion
12101	111.9	15.4
12111	110.9	18.1
12107	122.7	18.5
174525	117.6	20.9
174526	115.2	19.9

C. c. leucodonta is separated from *C. c. phaeus* by the following characters: Nasals less tapering posteriorly and shorter in *leucodonta;* interorbital constriction broader; foramen magnum narrower (exception, *phaeus* no. 210 has a narrower foramen magnum than *leucodonta* no. 12107); maxillary tooth-row shorter in *leucodonta;* ratio of maxillary tooth-row to basilar length less; palate anteriorly (see fig. I) broader (no. 12107, 6.9 mm.; 12101, 6.9;

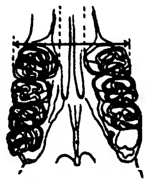


Fig. I. Ventral aspect of palate, to show method of taking measurements. Shorter measurement is "palate anteriorly". Longer dimension is that to show the tooth-flare. Approximately one-half natural size.

12111, 6.8. No. 209, 5.6 mm.; 210, 5.1); blade of hamulars (see fig. F, p. 430) slightly broader (no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8. No. 209, 4.1; 210, 4.1).

CASTOR CANADENSIS PACIFICUS RHOADS, FROM THE MAINLAND OF BRITISH COLUMBIA AND WASHINGTON

MATERIAL

Eleven specimens, all from the collections contained in the U. S. National Museum: Puget Sound, 1 (no. 3936, jaws only); Skagit River [Washington], 1 (no. 3672[1], skull only); Lake Cushman, Mason County, Washington, 8 (nos. 71276, 71812, 71814, 78395, 87628, 87629, skulls only, and nos. 71830, 71833, skins only, Biol. Surv. coll., in U. S. Nat. Mus.); Keechelus Lake, Washington, 1 (no. 126190, Biol. Surv. coll.); Fisher, Five River Valley, Oregon, 2 (nos. 136605, 136606, skulls only, Biol. Surv. coll.).

COMPARISON WITH *Castor canadensis leucodonta* GRAY, FROM VANCOUVER ISLAND, AND WITH CERTAIN OTHER SPECIES OF BEAVERS

General external characters.—Material representative of external characters is limited. One young topotype skin of *Castor canadensis pacificus* Rhoads, from Lake Keechelus, Washington, is at hand. According to the label it was probably taken in February, 1903. No example of *Castor canadensis leucodonta* strictly corresponding in age and season with this topotype of *pacificus* is at

[1] This skull was specified by Allen (1877, p. 441) as from Europe, and was commented upon as presenting an exceptional character.

hand. Nearest in these respects are nos. 12103, 12104, from Hall's Ranch, Alberni Valley, Vancouver Island, taken June 15 and 18, respectively, 1910. As regards change in external characters with age, it should be called to mind that the modifications are not great in the material worked over (see p. 420). Respecting seasonal change our knowledge is less complete.

In *Castor c. leucodonta* the dorsal overhair appears darker than in *Castor c. pacificus* (see table XII, opposite p. 440, for comparison of characters). The general coloration belongs to the cinnamon series in both. The darker impression doubtless is the result of the presence in *leucodonta* of more dark hairs sprinkled in with the light, as, for example, in no. 12108. In *leucodonta* the dorsal underfur is a darker shade of brown than it is in *pacificus.*

Ventral coloration shows the same general relation, having a darker cast in *leucodonta* than in *pacificus.* The overhair ventrally is in *leucodonta* about as much darker than it is in *pacificus* as benzo brown is darker than cinnamon-drab. No color difference as regards underfur ventrally could be distinguished. The difference in coloration extends to the feet. The hind feet are hazel to carob brown in *leucodonta,* while in *pacificus* they are close to benzo brown.

General cranial characters.—Nasals in *Castor c. leucodonta* give the impression of being longer and narrower than in *pacificus,* though the measurements show the reverse to be true in the matter of length. Nasals in *pacificus* have their outlines somewhat more invaded laterally by the backward-extending tongues of the premaxillaries. This lateral invasion of the nasal outline occurs at a point farther anteriorly in *pacificus* than it does in either *leucodonta* or *belugae.* Beginning at the anterior end of the skull, and proceeding posteriorly, the nasal outlines are at first nearly parallel, then the premaxillaries interrupt the outline, and the nasals become somewhat narrowed, their lateral outlines again attaining a nearly parallel relation. This posterior parallel portion of the outline is longer in *pacificus* than in *leucodonta.* Looking at the crania in their anterior aspect there is manifest a tendency for the nasals to fall away in a regular curve from the median line. In *leucodonta,* on the other hand, the usual condition is a flattish area dorsally on the median line. In the mainland examples the nasals extend farther down on the side of the rostrum anteriorly, showing a condition which may be described as a droop. The nasals as a rule do

not extend posteriorly of a line connecting antorbital tubercles in either *leucodonta* or *pacificus.*

The lateral ridge on rostrum is more prominent in *leucodonta* than in *pacificus.*

The hamular blades are broad in *leucodonta* (see fig. F, p. 430); narrow in the Lake Cushman examples, and tending to show an intermediate condition in *Castor c. belugae* from Stuart Lake. Broad in two juvenals from Fisher, Oregon (nos. 136605, 136606) as well as in a young topotype skull of *pacificus* from Lake Keechelus, Washington. Measurements: *Castor c. leucodonta,* Vancouver Island, no. 12107, 4.4 mm.; 12101, 4.6; 12111, 4.8; *Castor c. pacificus,* Lake Cushman, Washington, no. 71814, 2.2 mm.; 87629, 2.8; *Castor c. belugae,* Stuart Lake, British Columbia, no. 77155, 3.1 mm.; 77150, 3.2; the two juvenals from Fisher, Oregon: no. 136605, 4.3 mm.; 136606, 3.8; the young topotype cranium of *Castor c. pacificus:* no. 126190, 4.3. In *leucodonta* this character varies little with age. That it may do so in other subspecies, however, is indicated by the fact that a young specimen of undoubted *Castor canadensis frondator* (no. 60355), has broad-bladed hamulars, while an older specimen of the same subspecies (no. 35946) has narrower ones.

The occipital crest is flattened in *leucodonta,* upright in all but one of the specimens of *belugae* from Stuart Lake, British Columbia, and in a majority of those of *pacificus* from Lake Cushman, Washington. The disparity between *pacificus* and *leucodonta* in this respect is shown by the measurements given in the tables (p. 445, and opp. p. 426) under the heading "most dorsal point on the outline of foramen magnum to occipital crest on the median line" (see fig. G, p. 431). To make the comparison fair, only the three oldest crania of *leucodonta* (nos. 12111, 12101 and 12107) should be taken into account.

The foramen magnum is similar in general shape. Range of the ratio of vertical diameter of foramen magnum to basilar length: In *belugae,* with old and young crania represented, 9.8 percent to 14 per cent; in *pacificus,* with adult skulls only represented, 9.0 per cent to 12.5 per cent; in *leucodonta,* with old and very young skulls represented, 11.3 per cent to 17.7 per cent.

The specimens from the mainland of British Columbia and Washington are clearly set off from *Castor canadensis canadensis* and its close relative *C. c. michiganensis* through the characters of

XV. CRANIAL MEASUREMENTS* OF *Castor canadensis pacificus* FROM THE MAINLAND† OF WASHINGTON STATE

(All measurements in millimeters)

Museum number	Sex		Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Most dorsal point on outline of foramen magnum to occipital crest on median line. (See fig. G)	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Ratio vertical diameter of foramen magnum to basilar length	Ratio maxillary tooth-row to basilar length	Ratio width of nasals to basilar length
78395	♂	....	116.7	92.1	65.2	24.1	50.1	22.7	30.5	20.7	14.5	19.6	12.4	26.1	19.5
71812	♂	....	118.7	94.3	64.2	24.9	49.3	22.6	29.3	19.1	13.1	18.9	11.0	24.7	19.0
87628	♀	....	118.5	95.3	64.6	23.7	48.4	22.6	30.0	20.3	13.3	17.7	11.2	25.3	19.1
3672	?	....	125.7	......	66.5	25.5	50.6	25.3	31.2	22.0	14.2	20.4	11.3	24.8	20.1
71814	♀	....	118.7	94.2	67.4	24.7	49.9	24.0	29.9	20.7	14.8	19.3	12.5	25.2	20.2
71276	♀	....	124.7	95.1	68.2	26.9	48.8	23.7	31.6	20.8	11.2	18.7	9.0	25.3	19.0
87629	♂	....	124.9	......	68.4	25.5	51.7	25.1	32.9	21.5	14.8	19.4	11.8	26.3	20.1

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of the present paper.

†All from Lake Cushman, Mason County, except no. 3672, which is from Skagit River.

certain cranial dimensions, condition of median process of interpterygoid fossa, and outline of nasals.

CASTOR SUBAURATUS SUBAURATUS TAYLOR, FROM THE SAN JOAQUIN VALLEY, CALIFORNIA

Material

Eleven specimens, skins with skulls, in collection of Museum of Vertebrate Zoology: Westley, near Grayson, Stanislaus County, California, 1 (no. 8869); Grayson, Stanislaus County, 2 (nos. 8987, 8988); Tuolumne River, 5 miles north of Grayson, 2 (nos. 12668, 12669); San Joaquin River, 5 miles north of Grayson, 1 (no. 12654); San Joaquin River, 10 miles north of Grayson, 4 (nos. 16382–16385); "Sespe River, Ventura County, California", locality possibly erroneous, 1 (no. 4918, skull only).

Comparison With *Castor canadensis pacificus* Rhoads, from Washington State, and *Castor canadensis frondator* Mearns, from the Colorado and San Pedro Rivers, Mexico.

General external characters

Specimens compared.—*Castor subauratus subauratus,* nos. 8869, 8987, 8988, 12654, 12668, 12669, 16382–16385, Mus. Vert. Zool., all from the general vicinity of Grayson, San Joaquin River, Stanislaus County, California, taken November 22 to March 25; *Castor canadensis pacificus,* no. 126190, U. S. Nat. Mus., Keechelus Lake, Washington, February (?), 1903; *Castor canadensis frondator,* no. 20751, U. S. Nat. Mus., San Pedro River, Sonora, Mexico, October 14, 1892.

Comparative material illustrative of external characters is inadequate, as the list of specimens compared shows. While of *subauratus* there is a good series, one skin only of *pacificus* is available, and this is representative of a young individual. The single specimen of *frondator* is an adult. Fortunately all the skins were taken during the winter months, so seasonal discrepancy is eliminated.

The California skins have less hair above than has the example of *pacificus.* Several of them have thinner hair below, also.

Coloration in *subauratus* is remarkably close to that in *pacificus* as illustrated in the material here compared. The color of the Lake Keechelus example has a slightly paler cast than that of the average of *subauratus,* for the reason that the overhair of the example of

XVII. EXTERNAL MEASUREMENTS* OF *Castor subauratus subauratus*, FROM STANISLAUS COUNTY, CALIFORNIA

Specimens arranged approximately in order of age from the top of table to bottom

(All measurements in millimeters)

Museum number	Sex	LOCALITY	Total length	Tail vertebrae	Hind foot	Ear†	Length, scaled portion of tail	Width, scaled portion of tail	Weight in pounds	Ratio width scaled portion of tail to length
16384	♂	10 mi. N. Grayson	834	391	155	27	234	88		37.6
12668	♂	5 mi. N. Grayson	960		170		265		21	
16385	♂	10 mi. N. Grayson	1064	493	185	31	298	124		41.6
16382	♀	10 mi. N. Grayson	1108		190		305	137		45.0
8987	♀	3 mi. N. Grayson	1038		192					
12669	♀	5 mi. N. Grayson	1090		185		282		27.5	
16383	♂	10 mi. N. Grayson	1118	513	187	35	311	133		42.8
8988	♀	Grayson	1135	360	195		310	140		45.2
12654	♀	5 mi. N. Grayson	1171		196	31	320	139	39.5‡	43.4

*For method of taking measurements see Taylor, 1911, p. 207.
†From crown of head to tip of ear, measured on medial surface of pinna.
‡Entrails removed.

pacificus is thicker than that in the series of *subauratus*, concealing the darker underfur more effectually.

Illustrative of modification in coloration within the same subspecies are the following observations on the coloration of base of tail. One specimen of *Castor s. subauratus* (no. 16383) has the coloration dorsally in this region paler than the rest of the series, approximately clay color. Ventrally the hairs are chestnut for nearly all their length. In another example (no. 8869) the hairs are pale in coloration both above and below, the colored ends being hazel instead of chestnut. In no. 12654, the type of *subauratus*, the hairs of this region are darker than the average of the rest of the series. Variation of about this amount is noted in all the subspecies of which adequate series are available. With all this modification, however, the series of ten skins of *subauratus* is remarkably uniform in general coloration.

The general aspect of the *subauratus* series is darker than that in *frondator*, the difference being due to darker underfur.

XVIII. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor s. subauratus	16385	298	124	41.6
Castor s. subauratus	16382	305	137	45.0
Castor s. subauratus	16383	311	133	42.8
Castor s. subauratus	8988	310	140	45.2
Castor s. subauratus	12654	320	139	43.4
Castor c. pacificus	126190	185	74	38.9
Castor c. frondator	20751	232	113	48.9

General cranial characters

Crania compared.—*Castor subauratus subauratus*, nos. 16383 ♂, 16384 ♂, 8988 ♀, and 12654 ♀, Mus. Vert. Zool., all from the vicinity of Grayson, San Joaquin River, Stanislaus County, California; *Castor canadensis pacificus*, nos. 3672, 71276 ♀, 71812 ♂, 71814 ♀, 87628 ♀, 87629 ♂, 126190 ♂, U. S. Nat. Mus., all from the mainland of Washington State; *Castor canadensis frondator*, nos. 60354 ♂, 3594 ♂, 35946 ♀, from the Colorado River, Mexico, 15 miles south of Yuma, Arizona, and from the San Pedro River, Mexico, respectively.

Comparable crania of *Castor s. subauratus* exhibit a tendency to be larger than those of *Castor c. pacificus*. They exceed those of *pacificus* absolutely in width of nasals and ratio of width of nasals to basilar length. Vertical diameter of foramen magnum less in all comparable crania of *subauratus* than in *pacificus* or in *frondator* with one exception (*pacificus* no. 71276 has this diameter 11.2, which is the same as that in *subauratus* no. 16383); and associated with this difference, the ratio of vertical diameter of foramen magnum to basilar length is less in the comparable crania of *subauratus* than it is in *pacificus* (with the single exception mentioned) or in *frondator*.

The anterior dilation of the nasal outline in *subauratus* is marked; it clearly separates the California form from *pacificus*, but not from *frondator*, though absolute measurements in *subauratus* exceed those in the latter.

In *subauratus* the extension of the nasals posteriorly of a line connecting the points of the antorbital processes is greater than in *pacificus*, but less than in *frondator* (actual measurements: *subauratus*, no. 16383, 1.0 mm.; 8988, 0.8. In *pacificus*, nasals pos-

XX. CRANIAL MEASUREMENTS* OF *Castor subauratus subauratus*, FROM WESTERN CALIFORNIA†

Specimens arranged approximately in order of age from top of table to bottom

(All measurements in millimeters)

Museum number	Sex	Basilar length of Hensel	Zygomatic width	Mastoid width	Interorbital constriction	Length of nasals (See fig. C)	Width of nasals	Maxillary tooth-row	Length of fronto-maxillary suture‡	Vertical diameter of foramen magnum. (See fig. E)	Transverse width of foramen magnum	Greatest length of mandible; angle to anterior surface alveolus of incisor. (See fig. D)	Ventral surface of mandible to coronoid	Ratio width of nasals to basilar length	Ratio maxillary tooth-row to basilar length	Ratio vertical diameter of foramen magnum to basilar length
16384	♂	92.5	76.7	52.5	21.2	38.6	20.2	24.7	5.1	13.1	18.4	85.1	48.6	21.8	26.7	14.2
12668	♂	107.5	86.5	61.5	22.4	46.5	22.6	23.9	5.0	13.0	19.3	94.2	55.5	21.0	22.2	12.1
8869	♂	109.7	89.2	62.4	24.6	46.7	23.1	29.7	5.7	11.2	19.3	97.4	57.2	21.1	27.1	10.2
16385	♂	114.2	92.5	62.1	23.6	47.9	25.0	30.7	5.4	11.3	19.9	101.0	59.3	21.9	26.9	9.9
16382	♀	112.4	92.7	65.7	25.6	48.8	25.1	29.7	6.0	10.1	18.3	99.9	59.3	22.3	26.4	9.0
8987	♀	112.6	89.4	63.8	23.5	50.3	24.2	30.1	5.5	10.6	18.2	98.3	58.4	21.5	26.7	9.4
12669	♀	116.0	94.3	66.8	25.5	51.1	25.7	31.0	5.6	12.2	18.8	104.8	59.1	22.2	26.7	10.5
4918	♂	116.2	98.2	66.9	26.4	49.0	26.4	29.9	4.8	11.2	17.5	104.7	61.5	22.7	25.7	9.6
16383	♂	120.1	96.7	66.2	25.7	49.6	26.6	32.1	5.3	11.2	19.3	105.7	61.7	22.2	26.5	9.3
8988	♀	119.8	94.5	69.4	25.6	51.3	25.8	31.1	4.6	9.9	18.6	104.5	60.9	21.5	26.0	8.3
12654	♀	126.3	103.4	70.5	28.3	54.6	28.2	34.5	3.8	10.1	18.2	111.3	65.2	22.3	27.3	8.0

*For manner of taking measurements see Taylor, 1911, pp. 206, 207, and table opp. p. 426 of the present paper.

†All from vicinity of Grayson, Stanislaus County, except no. 4918, which is supposed to have been obtained near Sespe, Ventura County.

‡Length of fronto-maxillary suture: taken in region of anterior root of zygomatic arch; fit one point of dividers into point of meeting of frontal, premaxilla and maxilla; follow suture between maxilla and frontal laterad; adjust the other point of dividers at first point where maxilla touches jugal.

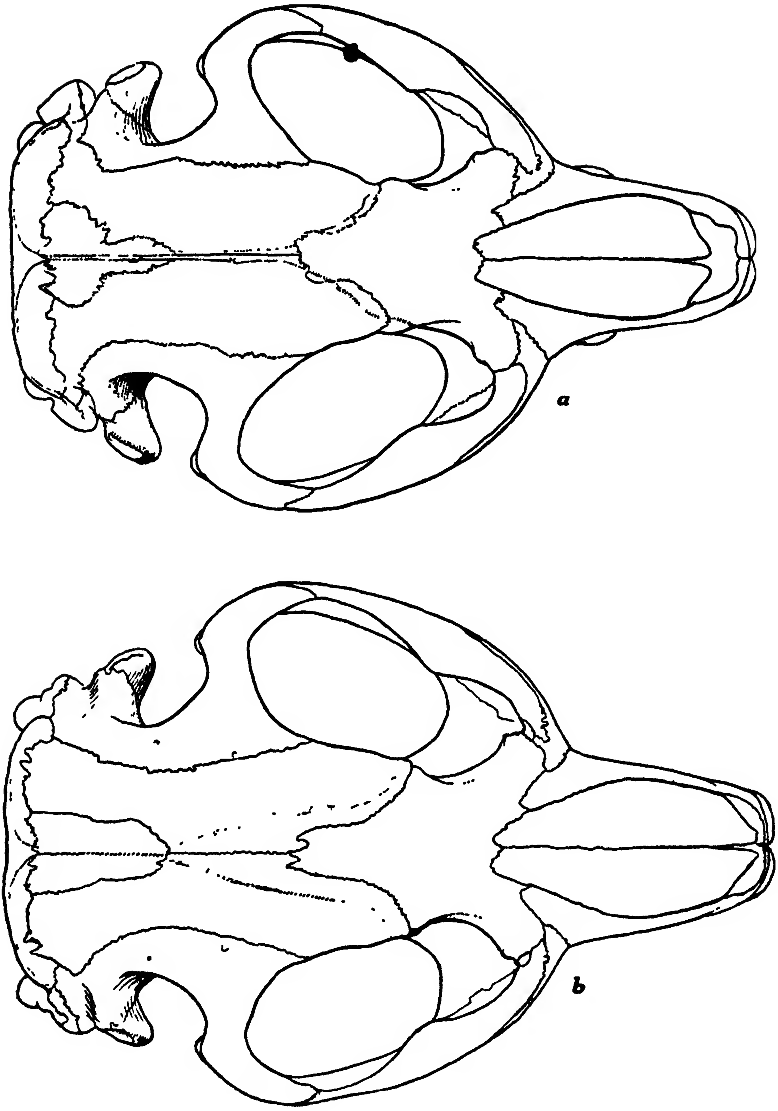


Fig. J. Dorsal view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus.* Note the different outline of the nasals and interparietal; the different conformation of the temporal ridges and the external auditory meatus; and the more massive character of the skull of the golden beaver. Approximately two-thirds natural size.

a. Castor canadensis leucodonta, no. 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

b. Castor subauratus subauratus, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

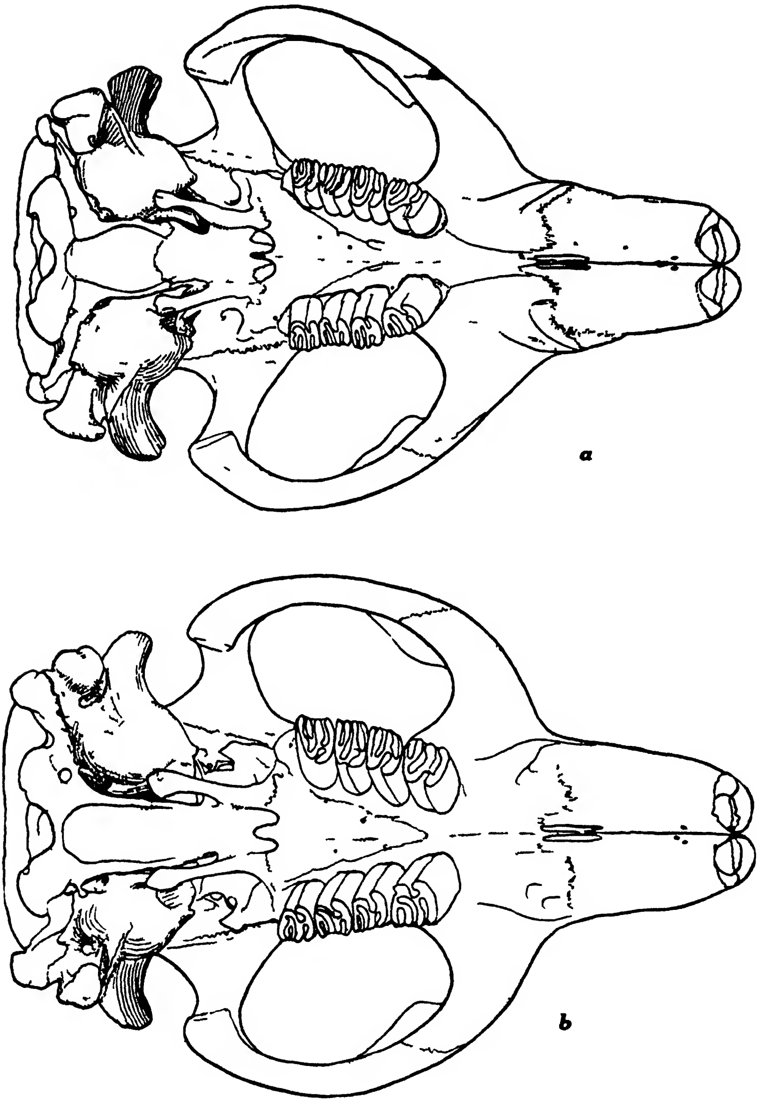
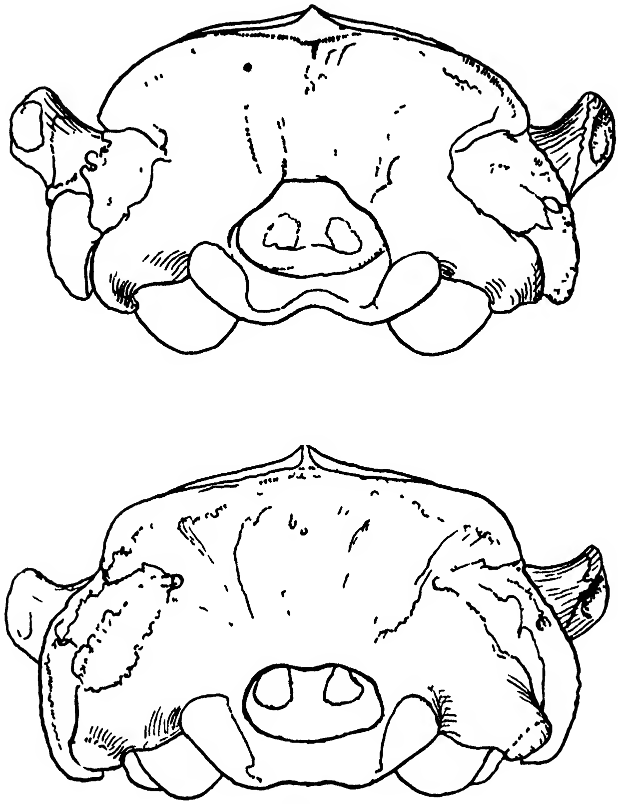


Fig. K. Ventral view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus* Note the different breadth of rostrum; the difference in squareness anteriorly of the zygomata, the difference in hamulars and median process in the interpterygoid fossa; in the mastoids, the paroccipitals, the external auditory meatus, and the position of the occipital condyles Approximately two-thirds natural size.

a. *Castor canadensis leucodonta*, no 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia.

b. *Castor subauratus subauratus*, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.



b

Fig. L. Posterior view crania of *Castor canadensis leucodonta* and *Castor subauratus subauratus*.[2] Note the different outline of the foramina magna; the difference in the external auditory meatus, and in general massiveness of crania. Approximately natural size.

a. *Castor canadensis leucodonta*, no. 12107, ♀, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia

b. *Castor subauratus subauratus*, no. 12654, ♀, Mus. Vert. Zool.; Grayson, San Joaquin River, Stanislaus County, California.

teriorly approximate the line in some specimens, in others fail of doing so by several millimeters; *frondator*, no. 60354, 2.6 mm.; 35946, 3.3 mm.).

[2] In figs. J, K, and L comparison has been made between *Castor s. subauratus* and *Castor c. leucodonta* instead of *Castor c. pacificus*. For textual comparison of cranial characters of *leucodonta* and *pacificus* see pp. 442 to 446. They differ in nasal outline, breadth of hamular blades, and, as a rule, in the condition of occipital crest.

Rostra attain greatest breadth in *subauratus* (measured outside of swellings made laterally by ridge involving maxillary and premaxillary bones [see fig. M]; in *subauratus*, no. 16383, 34.8 mm.; 8988, 33.5; 12654, 37.8. In *pacificus*, no. 3672, 34.9 mm.; 71276, 33.6; 71812, 33.4; 71814, 31.7; 78395, 34.5; 87628, 32.7; 87629, 34.3. In *frondator*, no. 60354, 35.5 mm.; 35946, 30.2).

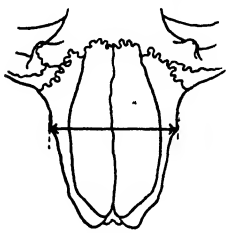


Fig. M. Dorsal view of rostrum, to show method of taking measurement. Approximately one-half natural size.

Hamular processes of pterygoid bones (see fig. F, p. 430) are broadest in *subauratus* (*subauratus*, no. 16383, 4.1 mm., 8988, 4.2, 12654, 4.3; *pacificus*, no. 3672, 2.1 mm., 71812, 2.5, 71814, 2.2, 78395, 3.4, 87628, 2.0, 87629, 2.8; *frondator*, no. 35946, 2.5 mm.). The two juvenals of *pacificus* from Fisher, Oregon, measure as follows: no. 136605, 4.3 mm.; no. 136606, 3.8. The young topotype cranium of *pacificus* from Keechelus Lake, Washington (no. 126190), has hamulars 4.3 mm. broad. The broader hamulars in the younger crania of *pacificus* would seem to indicate that this is a character which is different in individuals of different ages (see p. 444).

Mastoid process on the average is closest to auditory bulla in *subauratus* (see fig. N). Auditory bulla is of somewhat different shape in *subauratus* than in *pacificus* or *frondator*.

The following comments are in order respecting certain characteristics of *subauratus* as shown by the tables of measurements, p. 449 and opposite p. 438:

Fig. N. Ventral view of mastoid region, to show position of mastoid process relative to auditory bulla. About one-half natural size.

(1) The golden beaver is not, in most respects, on the basis of all the material, larger than the *canadensis* series of beavers. Most of the dimensions of no. 12654 of *subauratus* are greater than those of the largest skulls of any of the forms tabulated, however, except some of the individuals of its own subspecies *shastensis*, so that with complete material a size difference between *subauratus* and the *canadensis* series might be proved.

(2) Small vertical dimension of the foramen magnum would serve immediately to distinguish skulls of *subauratus* from those of any other western form of beaver, except in its own subspecies *shas-*

tensis, and in the following additional instances. Nos. 12668 and 16384, the youngest examples of *subauratus,* have foramina magna of larger dimensions than the older crania of that subspecies, and are not so characteristically marked off from other species of beavers. Furthermore, no. 4232, from the Cook Inlet region, has as short a vertical diameter of foramen magnum as has *subauratus,* as have also two very young specimens of *leucodonta* (nos. 12105, 12106), and one specimen of *pacificus* (no. 71276).

This measurement, the vertical diameter of the foramen magnum, is less, with the above exceptions, than in any other specimen of beaver measured. The transverse diameter averages less than in *phaeus,* although it averages about the same as in *leucodonta, pacificus* and *belugae,* and greater than in *frondator* or *canadensis* from eastern Canada.

The ratio of the vertical diameter of the foramen magnum to the basilar length brings out concretely its different shape. This ratio is nearly forty-six percent (taken on the basis of comparison of averages derived from table X, opposite p. 438) greater in *leucodonta* and fifty-one per cent greater in *frondator* than it is in *subauratus.* It will be noted that the ratio decreases with age, the foramen magnum in the youngest example (no. 16384) being nearest to the *canadensis* series (see table XX, p. 449).

(3) The ratio of the width of nasals to basilar length is greater in every specimen of *subauratus,* and in four of the five specimens of *shastensis,* than in any other subspecies of western beaver measured (except several specimens of *belugae,* and three examples of *leucodonta*).

(4) The ratio of the length of maxillary tooth-row to basilar length averages greater in comparable skulls of *subauratus* than in *pacificus,* its nearest neighbor on the north, but practically the same as in *frondator,* its nearest neighbor on the south.

CASTOR CANADENSIS FRONDATOR MEARNS, FROM THE COLORADO AND SAN PEDRO RIVERS, MEXICO

MATERIAL

Three specimens from United States National Museum: San Pedro River, Mexico, 1 (no. $\frac{35846}{20781}$, skin and skull); Lagoon of Colorado River, about 15 miles south of Yuma, Arizona, 2 (nos. 60354, 60355. skulls only).

Comparison With *Castor canadensis leucodonta* Gray, from Vancouver Island, *Castor canadensis pacificus* Rhoads, from Washington State, *Castor canadensis canadensis* Kuhl, from Eastern Canada, and *Castor canadensis belugae* Taylor, from Cook Inlet Region, Alaska

General external characters

Specimens compared.—*Castor canadensis frondator,* no. 20751 ♀, U. S. Nat. Mus., from San Pedro River, Sonora, Mexico, October 14, 1892; *Castor c. leucodonta,* nos. 12101-12111, Mus. Vert. Zool., all but the last (which is from Great Central Lake) from Alberni, Vancouver Island, British Columbia, June 11 to August 25, 1910; *Castor c. canadensis,* no. 4358 ♂, U. S. Nat. Mus., Moose River, Ontario, Hudson Bay region, May 21, 1860; and nos. 174525 ♂, 174526 ♀, both U. S. Nat. Mus., Nepisiquit River, New Brunswick, September 25, 1911; *Castor c. belugae,* no. 4347 ♂, Mus. Vert. Zool., Snug Harbor, Alaska Peninsula, Cook Inlet region, June 14, 1904.

Since *leucodonta* is, in general, close to *pacificus,* and since no material of *pacificus* representative of external characters and comparable with *frondator* is available, comparison has been made between *frondator* and *leucodonta.*

XXI. Measurements and Ratios of Scaled Portions of Tails

All measurements in millimeters, and taken in dry skins; see fig. H, p. 431

Subspecies—	Museum number	Length	Width	Ratio width to length
Castor c. frondator	20751	232	113	48.9
Castor c. leucodonta	12101	237	120	51.0
Castor c. leucodonta	12111	243	108	44.6
Castor c. leucodonta	12107	270	124	46.0
Castor c. canadensis	174525	265	116	43.4
Castor c. canadensis	174526	260	108	41.3
Castor c. canadensis	4358	223	92	41.1
Castor c. belugae	4347	245	115	47.0

In general, the pelage is not so heavy-weighted, either in *frondator* or in *leucodonta* as in *canadensis.* General coloration in *canadensis* dark; in *leucodonta* paler; in *frondator* lightest. *Frondator* has the most uniform coloration. The overhair laterally is, however, of a brighter tint than that mid-dorsally, the lightest area being the cheeks. The single skin of *belugae* is darker than *frondator,* but paler than the New Brunswick *canadensis.* In proportions of tail it is closer to *frondator* than are the examples of *canadensis.* Proportions of scaled portion of tail are not clearly separative as regards

frondator, *leucodonta*, and *belugae*, at least on the evidence here submitted, though *canadensis* would seem to be separated off by its narrow tail.

General cranial characters

Crania compared.—*Castor canadensis frondator*, nos. 60354 ♂, 35946 ♀, U. S. Nat. Mus., from the Colorado River, Mexico, 15 miles south of Yuma, Arizona, and from the San Pedro River, Mexico, respectively; *C. c. pacificus*, nos. 3672, 71276 ♀, 71812 ♂, 71814 ♀, 87628 ♀, 87629 ♂, 126190 ♂, U. S. Nat. Mus., all from the mainland of Washington State; *C. c. canadensis*, nos. 174525 ♂ and 174526 ♀, U. S. Nat. Mus., Nepisiquit River, New Brunswick; *C. c. belugae*, nos. 4347 ♂, 4225 ♂, 4224 ♂, Mus. Vert. Zool., Cook Inlet region, Alaska.

Nasals of different outline in *frondator* than in *pacificus*. Their lateral outlines converge more regularly in a posterior direction, there being no tendency to be parallel, as is the case in comparable skulls of *pacificus*. The ratio of width of nasals to length tends to be greater in *frondator* than in *pacificus*, though there is decided overlapping. Measurements of foramen magnum similar, though most specimens of *pacificus* have their foramina broader in proportion to vertical diameter than is the case in *frondator*. Teeth in one specimen of *frondator* flare more laterally than in any specimen of *pacificus* (see fig. I, p. 442, *frondator*, no. 60354, 34.3 mm., 35946, 30.9; *pacificus*, no. 3672, 33.1 mm., 71276, 31.3, 71812, 30.4, 71814, 34.1, 78395, 32.5, 87628, 32.6, 87629, 34.3). Ratio of maxillary tooth-row to basilar length greater in *frondator*. Tooth-row longer in *frondator* no. 60354 than in *pacificus* no. 71812. These specimens have basilar length identical. Tooth-row longer in *frondator* no. 35946, with basilar length of 111.7 mm., than in *pacificus* no. 71812, with basilar length of 118.7.

Median process in interpterygoid fossa longer and sharper in *frondator* than in *pacificus*.

These differences between *frondator* and *pacificus* are for the most part slight. The outline of nasals is the most dependable single separative character.

Measurements fail to separate *frondator* either from *canadensis* or the Cook Inlet race. Distance from the inion to dorsal outline of foramen magnum less in *frondator* than in *canadensis* from New Brunswick (*frondator*, no. 60354, 18.9 mm., 35946, 18.0; *canadensis*, no. 174525, 20.9 mm., 174526, 19.9). Ratio of maxillary tooth-row to basilar length slightly greater in *frondator* than in the New Bruns-

wick examples. Zygomata not quite so square anteriorly in *frondator* as in specimens of *belugae* from Cook Inlet. Also distance from dorsal outline of foramen magnum to inion less (see fig. G, p. 431; *frondator,* no. 35946, 18.0 mm., 60354, 18.9; *belugae,* no. 4347, 20.5 mm., 4225, 22.4, 4224, 22.7); teeth narrower on average (see table of measurements, p. 428).

Nasal outline, condition of median process in the interpterygoid fossa, and certain skull dimensions, show the affinities of *frondator* to be with *canadensis* rather than with either *subauratus* or *pacificus.*

Outline of the History of the Beavers

The Castoridae and Castoroididae are probably derived from that primitive Eocene rodent stock represented in the family Ischyromyidae. Matthew (1910, p. 67) has outlined their possible relationships to this family, postulating their descent from the North American *Paramys,* an ancient squirrel-like form which with its contemporary relatives was perhaps ancestral to most, possibly to all, the members of the great order Rodentia. It has so far been impossible definitely to work out whether *Plesiarctomys* from the French Upper Eocene is congeneric with *Paramys* or distinct from the American genus.

According to Matthew's scheme, *Paramys* gave rise to *Sciuravus* of the North American Eocene, which in its turn is tentatively placed as the ancestor, on the one hand, of the stock which gave rise to *Eutypomys* of North American Middle Oligocene, and on the other, of that from which the important genus *Steneofiber* is derived. These two genera are the earliest which are referred by Osborn (1910, p. 535) to the Castoridae.

Concerning *Eutypomys* very little is known. Osborn refers to it as a ground-squirrel or semi-cursorial type, and suggests that it may be related to the Pteromyinae. It seems to be of little importance to the phylogeny of beavers. On the contrary, *Steneofiber* assumes a place of great importance in this phylogeny, being the supposed ancestor of most of the later genera belonging to the beaver family.

Steneofiber, which was about the size of a marmot, appears first in the Middle Oligocene (Stampian) of Europe, also throughout the Upper Oligocene of North America, being abundant and characteristic in the Upper John Day of Oregon. Evidently it became extinct soon after, for it has not been discovered in later deposits. At least by

Upper Oligocene, it should be remarked, *Steneofiber* had attained a world-wide distribution. It was replaced, in the Lower and Middle Miocene of Europe, by *Chalicomys,* which died out during the Pliocene. Matthew derived the phylogenetic side-line represented by *Hystricops* of the North American Miocene and Pliocene from *Steneofiber.*

Little is known concerning the genus *Euhapsis,* a supposed castorid genus which occurred in North America during Upper Oligocene.

Eucastor or *Dipoides* of Upper Miocene, as well as the genus *Castor* itself, which first appeared in that period, are probably also descended from *Steneofiber. Eucastor*, which was, like *Steneofiber,* about the size of a marmot, is first found in the North American *Hipparion* and *Procamelus* zones (Upper Miocene) and ranges into the Pliocene. *Sigmogomphius* (Merriam, J. C., 1896, p. 365) from the Pliocene near Berkeley, California, and *Dipoides,* from the Pliocene of Asia, are closely related to if not congeneric with it. Apparently the *Eucastor-Dipoides* stock appeared first in North America, spreading later into Eurasia. The *Eucastor* line soon ran out in the Old World, while in North America it appears to have given rise to the Pleistocene family *Castoroididae* with its characteristic genus *Castoroides.*

The earliest species of the European genus *Trogontherium* appeared in the Upper Pliocene, being there represented by teeth much smaller than those of its successor in the Pleistocene, *Trogontherium cuvieri,* the giant beaver of Europe, which was about one-fifth larger than the beaver of modern times. This genus coexisted in Europe with *Castor,* but died out at the close of what Osborn calls the First Faunal Subzone of the Second Pleistocene Fauna.

The largest species of the Pleistocene *Castorides* of North America attained the size of a black bear, and was, like the big European *Trogontherium,* preceded by a smaller form.

The genus *Castor,* on the basis of evidence now at hand, appeared somewhat earlier in Europe than in America. The Pontian Upper Miocene deposits are the first in Europe in which *Castor* has been discovered. The recent discovery (Kellogg, 1911, p. 401) of a beaver-tooth in the Pliocene of California seems to indicate that it soon attained a distribution embracing both continents. *Castor* is found in Pliocene and Pleistocene European formations, and is widespread in North American Pleistocene. It is lacking from the Pliocene and

all earlier formations of the latter continent except for the one instance mentioned above, the correlation of the formation in which the tooth was found being still somewhat uncertain.

If there has not been independent origin of *Steneofiber, Eucastor-Dipoides,* and *Castor* itself on the Eurasian and North American continents, it is clear that there have been several intercontinental migrations of beavers. Although we are not able to state exactly the number of these migrations, the evidence indicates that there were at least three.

While it is realized that negative evidence is likely to prove untrustworthy, and that possible errors in correlation introduce a further element of uncertainty into general statements as to the origin and migration of the castorids, insofar at least as these are based on relative time of appearance, it is believed that the following tentative propositions merit consideration.

Steneofiber probably developed first in the Old World, since it is found in Europe in Middle Oligocene while it does not appear in North America until the Upper Oligocene. By late Oligocene time, therefore, its migration had apparently carried it into North America.

The fact that the John Day epoch of the Oligocene is marked by the disappearance of almost all the European migrants which are so characteristic of the earlier White River fauna, with other evidence, has seemed to show that the land connection with the Old World was broken (Scott, 1913, p. 116). The case of *Steneofiber* might be taken to indicate, though such an isolated instance is probably not worth much, that the White River land connection was maintained into the early part of the John Day phase of the Upper Oligocene. It is more probable that *Steneofiber* crossed the connecting land bridge during White River time, but did not attain a widespread distribution until the John Day epoch.

The *Eucastor-Dipoides* stock would seem to have taken origin in North America, since it is first found in the Upper Miocene of that continent. By Pliocene time it had migrated at least into Asia. It seems certain that Bering Strait was closed during at least a great part of that epoch (Scott, 1913, p. 125).

The genus *Castor* probably arose in Eurasia from *Steneofiber* or a closely related stock. A wave of migration carried it into North America during the Pliocene, probably by way of the North-Pacific land-connection, and its remains became widely distributed and fairly abundant in the Pleistocene.

Summary of Relationships of Certain North American Beavers

SOME DIFFICULTIES TO PRECISE STATEMENT OF RELATIONSHIP

Gregory (1910, p. 105) has called attention to the stumbling-blocks of the phylogenist, namely the two difficulties, first, of distinguishing between primitive and specialized characters, and second, between resemblances significant of genetic relationship and those indicating only convergence or parallelism.

That parallelism in evolution may be a principle more widespread and of greater significance than is ordinarily accorded it by taxonomists has recently been suggested (see Scott, 1913, pp. 649-656, and Hopkins, 1914, p. 187). It should be clearly recognized, however, that the weight of evidence indicates (Scott, 1913, p. 137) that independent origin of closely similar forms from different stocks in widely separated localities is practically unknown.

Emphasis should also be laid on the importance: (1) of determination of the order of appearance of diagnostic characters; and (2) of understanding the general adaptive significance of such characters, so that their broader phylogenetic and systematic value can be appraised (Gregory, 1910, p. 112). We are not now in position to prove in what order the diagnostic characters in the family here considered have appeared, or to state exactly the adaptive significance or insignificance of the characters. The fact that it is difficult to ascribe any adaptive value whatever to many of the characters which are diagnostic between subspecies and species of beavers does, however, suggest that these particular characters may be dependable as indicating relationship. Examples of such characters are: Different outlines of tail; different outlines of nasal bones; different degrees of development of median process of interpterygoid fossa; different shapes of foramen magnum; different breadths of hamular processes of pterygoids; different widths of bony palate anteriorly.

There are possible further difficulties. Since we do not certainly know that the evolution of one form has not taken place somewhat more rapidly than that of another, estimates of time of isolation (or age of a particular form) and closeness of relationship should only cautiously be based on degrees of difference.

CONSIDERATION OF CERTAIN NORTH AMERICAN FORMS

Certain problems remain to be considered regarding the relation-

ships of beavers, some of these being: (1) the relation of the beaver of North America to that of Europe and Asia, and (2) the interrelations of the North American forms. Under the second head arises the question whether groupings of the North American forms are possible, and since groupings *are* possible, further problems arise as to their interrelationships, their ancestry, and the causes and conditions in their differentiation.

The relationships of the American and Eurasian beavers have been more or less fully discussed by the following authors: Geo. Cuvier (1817, tome 1, p. 191, not seen; and 1825, tome 5, p. 57, not seen); Fred. Cuvier (1825, liv. 51, not seen); Brandt and Ratzeburg (1827, pp. 12-30); Brandt (1855, pp. 43-66); Morgan (1868, pp. 42-45); Ely (*in* Morgan, 1868, pp. 288-306); and Allen (1877, pp. 437-445). While sufficient material to justify a review of this point has not been available, the present writer has been able to compare three skulls of *Castor fiber* from the Elbe River, Germany, with the American beavers, and believes that the evidence indicates that they are specifically distinct.

Several points of possible significance arise in connection with the problem of the interrelationships of the North American beavers. Material illustrative of two species of Nearctic beavers, as well as of all their subspecies but two (*Castor canadensis carolinensis* Rhoads and *Castor canadensis mexicanus* Bailey), has been available in this study. Even a cursory examination of this material shows that all those beavers listed under *canadensis*, namely subspecies *canadensis, michiganensis, belugae, leucodonta, pacificus, frondator* and *texensis*, fall into one group, while those listed under *subauratus*, namely subspecies *subauratus* and *shastensis*, fall into another. Within these groups the subspecies appear to be closely related, their differentiation apparently having progressed to a slight extent only. From their geographical situation and from a consideration of such of their characters as may be worked out from the literature, species *caecator* Bangs and subspecies *mexicanus* Bailey and *carolinensis* Rhoads should be referred to the *canadensis* group.

The members of the *canadensis* group are, on the basis of available material, unequally related. For example, *Castor canadensis phaeus*, from Admiralty Island, Alaska, is less closely related to *Castor c. canadensis* of eastern Canada than is *Castor c. belugae* of the opposing mainland. *Phaeus* is more sharply marked off from the other subspecies of *canadensis* than are *Castor c. frondator* or *belugae*. *Phaeus*

cannot be said, on grounds of compared characteristics, to be closer to *belugae* than it is to eastern *canadensis*. *Belugae* is more closely allied to *canadensis* of eastern Canada than is either *Castor c. leucodonta* or *Castor c. pacificus*. It is impossible to decide to which of the two mainland subspecies (*belugae* or *pacificus*) *leucodonta* is most closely related. *Frondator* is more closely allied to *canadensis* of eastern Canada than it is to the California species of beavers or to the *belugae-leucodonta-pacificus* series. *Castor c. michiganensis* finds its closest relative in *canadensis*.

The California beavers stand by themselves, having undergone considerably more divergence than the other subspecies, and their immediate ancestry is decidedly uncertain. Mr. F. H. Holden, of the staff of the Museum of Vertebrate Zoology of the University of California, who has carefully compared such skeletons of beavers as are available, has called the writer's attention to the fact that the majority of skeletal characters of *Castor subauratus subauratus* would relate it rather to the Eurasiatic *Castor fiber* than to the North American *Castor canadensis*. This testimony, however, is not borne out by the skull characteristics, which would seem definitely to relate *subauratus* to the *canadensis* series. Perhaps the most striking differences between the *subauratus* series and the *canadensis* series are the different shapes of the foramen magnum and of the median process in the interpterygoid fossa. *Castor c. pacificus* and *Castor c. belugae* are somewhat more variable respecting these characters than are any other subspecies of *canadensis*, and individual skulls of these show a more decided bent in the direction of *subauratus* than do the other forms, which suggests the possibility that *subauratus* has been derived from the form which was ancestral also to the subspecies occupying the mainland of Oregon, Washington, British Columbia and Alaska. If this should be the case, the relationship of the California forms with *canadensis* would be close, and the comparatively large amount of divergence would be noteworthy as possibly indicating a more rapid evolution, or a more complete isolation from the parent stock (possibly both together) than is exemplified by the other forms.

Remarks on Isolation and Its Relation to Speciation

CONSIDERATION OF SOME OF THE EVIDENCE

Evidence from the Study of Beavers

We may now profitably undertake a review of some of the facts

of beaver distribution, with special reference to the problem of speciation in the group.

It should be remembered that the beavers of Eurasia and America, while not distantly related, are still very clearly marked off specifically. It should further be called to mind that there are, on the North American continent, two distinct groups of beavers, the *canadensis* group, including the species *canadensis* with at least its subspecies *canadensis, belugae, leucodonta, pacificus, frondator* and *texensis,* and the *subauratus* group, including the species *subauratus* with its subspecies *subauratus* and *shastensis.*

In the case of each one of these subspecies of beavers, geographic range seems to be as characteristic as any physical attribute. It should be emphasized that differentiation in beavers has progressed only to a slight degree as compared with, for example, the Geomyidae, and that all the forms of beavers, even the two groups, are relatively closely related. No case of overlapping of subspecific or specific ranges is known. Knowledge of the details of the relations of distribution of beavers to topography is not sufficient to warrant categorical assertions without some qualification, but available evidence points to the truth of the following general statements.

Castor c. michiganensis, a small, dark form, is very closely related to *C. c. canadensis,* its neighbor on the north. The type locality of *canadensis* is Hudson Bay, and the subspecies probably ranges south to the chain of Great Lakes, which would seem to be a barrier separating it from *michiganensis.*

The type locality of *Castor c. canadensis* (Hudson Bay) is connected by a nearly continuous series of streams and lakes with extreme western Canada. Distance is practically the only deterrence to the migration of individuals from eastern Canada to the base of the Canadian Rockies and the Alaskan Mountains. Subspecies *belugae,* of *canadensis,* occupying the Pacific territory from Cook Inlet to British Columbia, is closely related to *canadensis* on the one hand and to *leucodonta* and *pacificus* on the other. Subspecies *phaeus* of Admiralty Island, southeastern Alaska, is comparatively sharply marked off. *Frondator,* type locality San Pedro River, Mexico, which is supposed to range some distance to the north, is also closely related to *canadensis.* On the other hand, *subauratus* and its subspecies *shastensis* are much less closely related to *canadensis* than any of the other forms, and there do occur, bounding the range of the *subauratus* group, masses of high mountains on the north, east and south, as

well as broad deserts on the east and south. The two subspecies of *subauratus,* namely *subauratus* and *shastensis,* are much more closely related to each other than is either to any other known beaver in the world. Although they are inhabitants of the same hydrographic basin, they are efficiently separated by distance in combination with the "narrows", by way of which the Pit River cuts through the Sierra Nevada Mountains.

It must be immediately apparent that these facts, so far as they go, fulfill the requirements of Wagner and Jordan's law: "Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort."

It is now quite well established that on continuous land areas temperature is the most efficient of all barriers, with humidity of the atmosphere a close second. It is a remarkable fact that the genus *Castor* ranges, undergoing at the same time but little change, through all the life-zones (based on temperature) from the Hudsonian of the northern limit of trees to the Lower Sonoran of the southern deserts. and that it is found in faunal areas (based on humidity) as widely different as the Sitkan district of southeastern Alaska and the Colorado Desert of the southwestern United States. Although the semi-aquatic environment of the beaver is doubtless more uniform throughout this great range of temperature and moisture conditions than is the typical terrestrial environment, it must still be conceded that the genus *Castor* is subjected to very different environments in different parts of its range. The writer at this moment finds it impossible to assign any adaptive significance to the subspecific and specific differentiatory cranial characters of beavers. It must be confessed that the maintenance by the beaver of its chief characteristics through a very wide range of environmental conditions, coupled with the further fact that it is difficult to attribute any adaptive significance to the cranial specific and subspecific characters, invite one to the hypothesis that these characteristics of the different races of beaver are due to a cumulation of what are for the most part inutile characters through the fact of the geographical isolation, alone, of the various beaver stocks.

An alternative view is, of course, that our inability to see the adaptive significance of these differentiatory characters, or definitely to correlate them with characters which are obviously adaptive, merely testifies to the limitations of our own knowledge, and not at all that

these characters are really not adaptive or not correlated with some adaptation. However this may be, it would seem that the possibility that geographical isolation alone, with no assistance from natural selection, has been a condition in speciation of beavers, is by no means excluded.

Evidence from Certain Other Families of Mammals

Its great geographical extent and wide diversity of topographical and environmental conditions make California probably as favorable a geographic unit as could be found for the study of problems concerning the origin and maintenance of vertebrate species; and since the writer is more familiar with the mammalian fauna of California than with that of any other area, this particular field has furnished most of the material used. But published facts from mammalian distribution in the Great West, and in the continent generally, have been freely drawn upon.

In cases where the family or genus has recently been monographed, relationships as outlined may be regarded as more dependable than in those instances in which the group has not undergone adequate revision. In the latter the conclusions reached are tentative, and are based upon the writer's familiarity with the mammalian fauna in question.

Soricidae

Sorex vagrans vagrans, the range of which within California (Grinnell, 1913*a*, p. 270) includes the Upper Sonoran, Transition and Boreal zones in the western portion of the state, east to Shasta County and south as far as Monterey, finds in *Sorex vagrans amoenus* its nearest relative within the state. The range of the latter form takes in the Transition and Boreal zones of the Sierra Nevada Mountains, at least from Mono County north to Mount Shasta (Merriam, C. H., 1895, p. 68, and 1899, p. 87). *Sorex halicoetes,* of the salt marshes bordering the south arm of San Francisco Bay, is more closely allied to *Sorex vagrans vagrans* than it is to any other species of *Sorex* (Grinnell, 1913*a,* p. 184). It will be remembered that *Sorex vagrans vagrans* is found coastwise in California as far south as Monterey.

Sorex sinuosus of the brackish marshes of Grizzly Island, Suisun Bay, California, is most closely related to *Sorex californicus* of the neighboring uplands.

Note should be made of the distribution of the *tenellus* group of

subspecies. *Sorex tenellus tenellus* occurs on the Alabama Hills, near Lone Pine, Inyo County, California. *Sorex tenellus lyelli* is a closely related form occurring on Mount Lyell in the Sierra Nevada, and *Sorex tenellus myops* is known only from the White Mountains of Inyo County, California, which lie to the eastward of Mount Lyell near the California boundary line. *Sorex tenellus nanus* is an outlying relative found in the Rocky Mountains of Colorado.

The widely distributed *Sorex montereyensis montereyensis,* which is found in the Transition and Upper Sonoran zones of the northern and central coast districts of California from the Oregon line to San Luis Obispo County, has as its nearest relative *Sorex montereyensis mariposae,* which is also broadly distributed, being a montane form found in the Transition zone of the Sierra Nevada and Warner Mountains, and in the inner coast ranges as far south as Lierly's Ranch, four miles south of Sanhedrin Mountain, Mendocino County.

Sorex obscurus obscurus occurs in the Transition and Boreal zones of the Sierra Nevada Mountains from Mono County north. This is a subspecies of very broad distribution, being found in southern British Columbia and northern Washington and in the Rocky Mountains, as well as in the Sierra Nevada (Merriam, 1895, p. 73). Its closest allies are *Sorex obscurus longicauda,* occupying a narrow strip along the Pacific coast from the mouth of the Columbia River to Wrangel, Alaska, and *Sorex obscurus ventralis,* inhabiting the mountains of Oaxaca, in southern Mexico.

Neosorex bendirii bendirii, occupying in California the Transition and Boreal zones of the humid northwest coast belt from Humboldt Bay to Gualala, is also found in the Klamath Basin, Oregon, and thence northward along the east side of the Cascade Range to Puget Sound (Merriam, 1895, p. 96). Its closest allies are *Neosorex bendirii palmeri,* of the coast of Oregon and the Willamette Valley, and *Neosorex bendirii albiventer,* from Lake Cushman, Washington.

This terminates the list of the California Soricidae, the relationships of which are best known. Concerning *Sorex shastensis* from Mount Shasta, *Sorex pacificus* from the north coast district of California, and the *Sorex ornatus* series from Mount Pinos and other mountains of southern California, our knowledge is indefinite.

PROCYONIDAE

The Pacific raccoon, *Procyon psora pacifica,* type locality Keechelus Lake, Cascade Mountains, Kittitas County, Washington, ranges into

California on the north, occupying the Transition and Upper Sonoran zones along its northern border. The vicinity of Pit River, Shasta County, is its southern limit. Occupying both Lower and Upper Sonoran and Transition of the rest of the state except the southeastern deserts, is *Procyon psora psora,* the California raccoon, which is very closely related to its northern neighbor, and doubtless intergrades with it. Favorable situations in the southeastern desert region are inhabited by the pallid raccoon, *Procyon pallidus,* while a fourth California form has recently been described from the San Diegan region west of the Coast Range Mountains in extreme southwestern California (*Procyon psora californicus,* Mearns, 1914, p. 66).

MUSTELIDAE

The closest ally of *Martes caurina caurina,* the pine marten, the range of which includes the Transition and Boreal of northwestern California, is *Martes caurina origenes* which is found in the Boreal of the Rocky Mountains of Colorado (Cary, 1911, p. 189). *Martes pennanti pacifica,* the Pacific fisher, finds its closest living relative in *Martes pennanti pennanti* of eastern Canada. The Sierra Nevada and Mount McKinley wolverines, *Gulo luscus luteus* and *Gulo luscus hylaeus,* are closely related, and both are close to the *Gulo luscus luscus* of Canada.

Details of distribution and relationships of the weasels are hardly complete enough to be satisfactory. However, it is certain that the diminutive *Mustela muricus* of the Sierra Nevada is a member of the boreal *cicognanii* group of weasels. A close ally of *muricus* is resident on the Pine Forest Mountains of northern Nevada. An undescribed weasel most closely related to *Mustela streatori* of the Puget Sound district occurs on the north coast of California. The *Mustela arizonensis* is said (Merriam, 1896, p. 22) to be a mountain form of *Mustela longicauda* of the Great Plains from Kansas northward. *Mustela arizonensis* is found in the Transition and Boreal zones of the Sierra Nevada from Mount Shasta to Tulare County, as well as on the San Jacinto Mountains. Its distribution is stated as follows: "Broadly, the Sierra Nevada and Rocky mountain systems, reaching British Columbia in the Rocky Mountain region, but not known north of the Siskiyou Mountains in the Sierra-Cascade system". North of the Siskiyou Mountains in the Sierra-Cascade system occurs its close relative, *Mustela saturata.* The relationships of *arizonensis* are not clear, since Merriam states (*op. cit.,* p. 23) that Sierra specimens

show a strong tendency to grade into *xanthogenys*, the form of the California lowlands.

The closest relatives of *Mustela xanthogenys xanthogenys* of California west of the desert divides, from the Mexican line north through the San Diegan district, and in west-central California east of northern humid coast belt, at least to the head of the Sacramento Valley are *Mustela xanthogenys munda* (doubtfully recognizable) of the humid coast Transition north of San Francisco Bay, and *Mustela xanthogenys oregonensis*, of Rogue River Valley, Oregon.

The Pacific Mink, *Mustela vison energumenos*, is most closely related to its neighbors, *Mustela vison nesolestes*, of the Alexander Archipelago, Alaska, and *Mustela vison lacustris* of the interior of Canada and the northern United States (Hollister, 1913, p. 476).

Turning to the genus *Spilogale*, it is noted that two closely related forms invade eastern California but do not cross the Sierra Nevada. These are *Spilogale gracilis saxatilis*, found in the northeastern corner of the state, and *Spilogale gracilis gracilis*, inhabiting the Sonoran zones of the Inyo region. *Spilogale arizonae arizonae* of the lower Colorado River region is most closely allied to *Spilogale arizonae martirensis* of Lower California. *Spilogale phenax phenax*, inhabiting most of the Pacific slope of California, is apparently replaced by *Spilogale phenax latifrons* in the coast region of extreme northern California and Oregon. Another race of the species *phenax*, *Spilogale phenax olympica*, is found on the Olympic Peninsula and the shores of Puget Sound (Miller, 1912, p. 106).

The genus *Mephitis* is represented by five forms within California, three of these belonging to the species *occidentalis*. This species is represented in western North America by five races (Howell, 1901, pp. 34-38). *Mephitis occidentalis occidentalis* is found in northern and central California, west of the Sierra-Cascade system, from Monterey Bay to the Willamette Valley, Oregon. The coast region of Washington and northern Oregon, as well as the shores of Puget Sound, are occupied by *Mephitis occidentalis spissigrada*. In the eastern part of southern Washington and northern Oregon, on the desert side of the Cascade Mountains, is found *Mephitis occidentalis notata*, which intergrades with *occidentalis* and *major*. *Mephitis occidentalis major* is found in eastern Oregon, northeastern California and Nevada, ranging east to the Wasatch range in Utah. Its closest relatives are *notata* and *occidentalis*, its neighbors on the north and west respectively. In southern California the group is represented by

Mephitis occidentalis holzneri. The case of *Mephitis platyrhina* from the south fork of the Kern River and Owens Valley, California, is of interest and possible significance. Its range (Howell, *op. cit.*, p. 39) is overlapped by that of *Mephitis occidentalis holzneri.* If Howell's suggestion that *platyrhina* may intergrade with *major* be true, then the latter, occupying territory to the north, is the closest relative of *platyrhina.*

One other *Mephitis*, namely *Mephitis estor,* is found in California. This is probably an invader from the east, its geographic distribution including Arizona, western New Mexico, Sonora, Chihuahua, and northern Lower California, as well as the valley of the lower Colorado River in California. Although *Mephitis estor* is a very distinct species, its closest relative would seem to be *Mephitis mesomelas varians,* whose range lies to the east. Howell (1901, p. 33) goes so far as to suggest that it is possible that intergradation takes place between the two.

The California badger, *Taxidea taxus neglecta,* unquestionably intergrades with and is most closely related to *Taxidea taxus taxus* of eastern America. Specimens of badgers from the Pine Forest Mountain region of northern Nevada have been referred to the latter (Taylor, 1911, pp. 296, 297). In the arid southwestern United States and northern Mexico is found the Mexican badger, *Taxidea taxus berlandieri.* The fourth form is *Taxidea taxus infusca,* found in Lower California.

The aquatic genus *Latax,* which occurs off the west coast of America and the northeast coast of Asia, finds in the terrestrial and fluviatile genus *Lutra,* which is found both in Asia and North America, its closest living relative (Taylor, 1914, pp. 493, 495).

Muridae

The Muridae are represented in California by so large a number of groups and species that details may justifiably be omitted. This great family must not be passed over, however, without calling attention to the interesting data presented by the *Peromyscus maniculatus* series of mice. This group is represented by forty-three subspecies or small species distributed nearly throughout the North American continent.

This was the first to be named and almost the last to be recognized of a large group of inosculating forms—the largest and most remarkable of the genus and perhaps of American mammals. Its distribution is wider and the

number of intergrading forms and of individuals is greater than in any similar group of mammals known. From typical *maniculatus*, development may be traced step by step absolutely without break through all the numerous subspecies (Osgood, 1909, p. 41, and frontispiece).

Here we have a spectacular illustration of the principle that the closest relative of any form is found, not in a locality far distant nor in a locality identical with that occupied by the form, but in a neighboring region separated from the first by a barrier of some sort (see p. 464).

Respecting the Californian forms of the genus *Onychomys* it may with all assurance be said that no two species are found in one locality. This genus has recently been revised by Hollister (1914, pp. 427–489).

The distribution of the Murid genera *Reithrodontomys, Sigmodon, Neotoma, Evotomys, Microtus,* and *Fiber,* as well as of the genus *Peromyscus,* afford a mass of material similar to that which has already been adduced.

ZAPODIDAE

Zapus trinotatus trinotatus ranges from the coast region of southern British Columbia, Washington (including Cascades), Oregon (west of western base of Cascades), to northern California, being found as far south as Carson's Camp on Mad River, Humboldt County. Its closely related subspecies *Zapus trinotatus alleni* (Preble, 1899, pp. 27, 28) occupies the Boreal zone of the Siskiyou, Trinity, and Sierra Nevada mountains, as well as the inner coast range as far south as South Yolla Bolly Mountain (between Tehama and Trinity counties).

Zapus major is probably an outlying form with *trinotatus* affinities (Preble, 1899, p. 25). It is found on the Warner Mountains of Oregon and California. *Zapus orarius* is found in the humid coast belt of California from Marin County to Humboldt Bay. Its relationships are not clear, but it is probably nearest to *Zapus pacificus,* which is found in the interior valleys of southwestern Oregon and northwestern California.

APLODONTIIDAE

Although detailed facts regarding the aplodontias are not so numerous as is desirable, it seems obvious that the relationships of the California forms are as follows: The recently described *Aplodontia chryseola* (Kellogg, 1914, pp. 295, 296) occupying the Trinity and

Siskiyou mountains is most closely allied to *Aplodontia californica* of the Sierra Nevada Mountains. On the other hand, the coast forms, *Aplodontia pacifica,* found at Newport, mouth of Yaquina Bay, Lincoln County, Oregon, *Aplodontia nigra,* Point Arena, Mendocino County, California, and *Aplodontia phaea,* Marin County, California, would seem to be most closely related among themselves.

OCHOTONIDAE

This small but interesting family is found only upon or near the summits of the highest mountains in California. Three species are represented within the state, *Ochotona taylori,* of the high peaks of the Warner Mountains of northeastern California; *Ochotona schisticeps,* of the central and northern Sierra Nevada; and *Ochotona albatus,* of the Mount Whitney region, southern Sierra Nevada. It is not improbable that *Ochotona taylori* is more closely related to *Ochotona schisticeps* of the region intervening than it is to *Ochotona albatus* of the Mount Whitney region of the southern Sierra.

CERVIDAE

Odocoileus columbianus columbianus occupies the northwest coast region of California and northward at least to the Columbia River. It is found as far to the eastward in California as Mount Shasta and extends through the inner coast mountains to the Sacramento Valley. The Golden Gate, San Francisco Bay, separates it from the closely related *Odocoileus columbianus scaphiotus,* which is found in the Transition and Upper Sonoran zones southward through the Santa Cruz district into Monterey and San Benito counties.

Characteristic of the Sierra Nevada and the southern and desert ranges within the state is the mule deer. *Odocoileus hemionus hemionus* is found to be generally distributed in eastern California, from the southern end of the High Sierra north to the northeastern corner of the state. It comes in contact with *Odocoileus columbianus columbianus* in the Shasta region, where there may be some overlapping of range. From the Tehachapi Mountains (southern end of high Sierra Nevada) westward through the Tejon region to the coast mountains and southward to the Mexican line, west of the desert proper, occurs *Odocoileus hemionus californicus.* There formerly occurred on the deserts of southeastern California the burro deer, *Odocoileus hemionus eremicus,* but the subspecies seems now to be extinct north of the Mexican line. These forms of the mule deer are very closely related, and it is evident that they occupy adjoining ranges.

Summarization

Having now adduced evidence from a study of nine families of mammals, representative of four orders, we may profitably undertake to discover whither it leads us.

Before proceeding it ought to be stated that this evidence is typical of that which would be gathered in course of the consideration of any family whatever of California mammals. The evidence might be greatly extended, but such extension would imply much unjustified repetition, for further evidence would probably not illustrate the actual state of things any better than that which we now have at hand.

It should be remembered that our present concern is the gathering, so far as that may be here practicable, of the evidence on the differentiation of species, or polytypic evolution (the splitting up of a parent stock into a number of differentiated stocks), as opposed to monotypic evolution (continuous change through time and in a given direction of the entire stock without divarication). Thus we are not discussing the problem of the mode of organic evolution primarily, except in so far as this problem is bound up with considerations of differentiation.

Furthermore, we propose to discuss this matter from the standpoint of studies, first of mammals, and second, of the higher vertebrates in general. It is hardly to be assumed that the same conditions and factors of organic evolution apply universally, or that, where they do apply, they must act in exactly the same way.

An illustration of the heterogeneity of the organic world is fortunately furnished by the very problem with which we are here dealing, namely, that of the place of geographic isolation in specific differentiation. We are indebted to Kofoid (1907*a*, pp. 500-506) for calling pointed attention to the possible limitations of isolation in the origin of species. After remarking the high degree of cosmopolitanism of the fresh-water microfauna and flora, Kofoid emphasizes the fact that there is not only extensive coincident distribution of related species, but that there are numerous cases in which there is actual coexistence of the most closely related species in the same habitat.

Similar evidence is adduced by Clark (1911, p. 23), who demonstrates the coincident distribution of closely related species among the Ophiurans. There seems to be abundant evidence that very closely related species of this group, often the most closely related,

inhabit the same area, and that "Jordan's law" does not apply to this class of Echinoderms; and further, that "physiological isolation" in some form has been a more important factor than geographical or bathymetrical isolation in the specific differentiation of Ophiurans. This state of things stands, of course, in strong contrast with the widespread isolation of related species and subspecies in birds, mammals, and vertebrates generally (see p. 475).

RELATION OF EVIDENCE TO SOME CURRENT THEORIES

Do the facts of distribution which we have before us meet the requirements of Darwin's hypothesis as to the origin of species

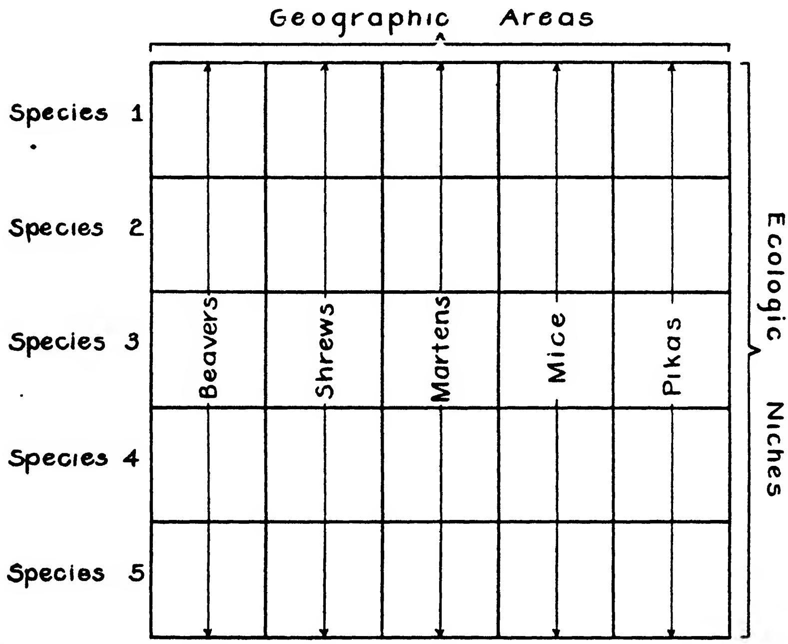


Fig. O. Diagram illustrative of species arrangement as we ought to find it in nature according to Darwin's theory of differentiation in the same place through the advantage of divergence.

through natural selection in the same place through the advantage of divergence? Do they accord with De Vries' theory of mutations, according to which the parent species, after passing into a mutation period, gives rise to one or more elementary species or retrograde varieties, which may coexist with the parent stock in the same locality? Do they fulfill demands of Romanes' and Gulick's physiological selec-

tion according to which there may be segregation of sections of the same species in the same place, and so divergent evolution, through preferential mating?

It will be apparent immediately that the facts here adduced do not harmonize with the requirements of any of the hypotheses above mentioned; for on any one of them we ought, at least occasionally, to find species arranged in nature as illustrated in the accompanying diagram (fig. O). According to this diagram each group is represented to have undergone divergence in the same place, until its members occupy different ecologic niches, the horizontal lines representing physiological, the heavy vertical lines geographical, barriers. What we do find in nature is that species are arranged quite otherwise (fig. P).

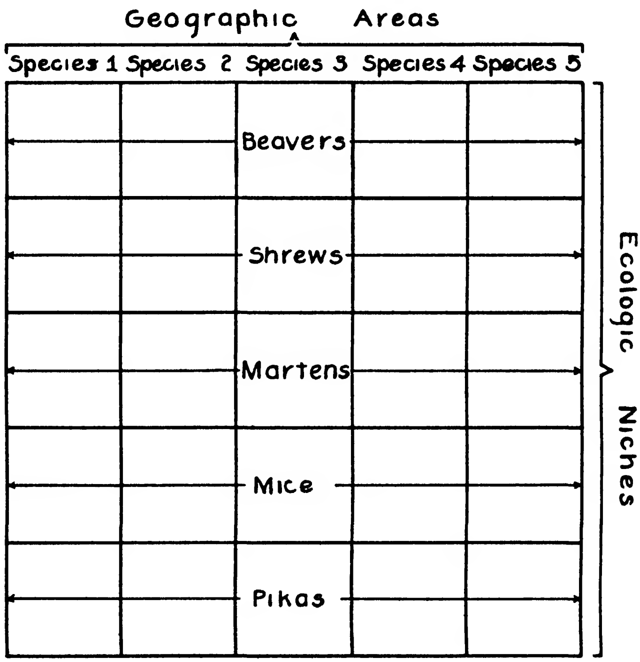


Fig. P. Diagram illustrative of species arrangement as we actually do find it in nature.

Each group, speaking now in general terms, for there are some exceptions, occupies the same ecologic niche in different places, rather than different ecologic niches in the same place. The two propositions are theoretically well balanced, and on *a priori* grounds one would perhaps be unable to discover any argument in favor of the one arrange-

ment as over against the other. But the facts of geographical distribution of higher vertebrates point unequivocally to figure P as a more accurate illustration of species arrangement than is figure O.

Relation of Evidence to Wagner's Theory of Migration and Geographical Isolation

There is left Wagner's theory, that the differentiation of species has taken place through migration and geographical isolation, the migration and spatial isolation being, according to this view, the conditions without which specific differentiation does not take place. With this proposition the evidence from mammals and higher vertebrates in general seems to be, for the most part, in complete harmony. The terms of this theory demand that a group made up of closely related forms be represented by one species or subspecies, only, in each locality, and that the most closely related forms be separated by some barrier which shall keep them from interbreeding to an extent that would bring about the swamping of incipient characters. In other words, on this theory, groups of related species should be arranged as illustrated in figure P. And so they are.

Reference has already been made (p. 472) to Kofoid's suggestion regarding the coincident distribution of some of the most closely related species of the fresh-water microfauna and flora. In another paper (1907*b*, pp. 241-251) the same author considers the distribution of the Chaetognatha with reference to its bearing on the relation of isolation to the origin and preservation of species, coming to the following conclusion: "The apparently wide-spread phenomenon of coincident distribution of related species among pelagic organisms appears to cast some doubt upon the universality of the operation of isolation in the evolution of species as originally maintained by Moritz Wagner (1868) and recently revived by President Jordan (1905)." In the course of this paper Kofoid emphasizes the lack of specific distributional data, especially of that pertaining to vertical distribution.

Supplementary in a way to this work of Kofoid is an exceedingly suggestive paper dealing with the problem of isolation *versus* coincidence in the same group (the Chaetognatha) recently published by Michael (1913, pp. 17–50). The extensive collection of specific data with regard not only to latitudinal and longitudinal but also to vertical distribution permits the enunciation of the following principle (Michael, 1913, p. 18): " . . . Pelagic organ-

isms may be coincidently distributed as regards latitude and longitude, and still be completely isolated in their vertical distribution."

The results of Michael's work indicate that the increase of exact knowledge in at least one group of oceanic organisms has emphasized the possible significance to these organisms of isolation.

It is concluded (Michael, 1913, p. 46) that "Jordan's Law" is only partly true, when tested by vertical distribution, for while the most closely related species do not inhabit the *same* environment, they do inhabit the most *remote* environments; and that the more closely related species of Chaetognatha are isolated from each other either horizontally, vertically, or by virtue of physiological differences causing fertilization to take place in different strata of water.

Attention should be called to the following points in connection with the data presented on pages 465 to 472 of the present paper, at which the evidence apparently does not clearly harmonize with Wagner's theory.

Sorex halicoetes of the San Francisco salt marshes is separated from its closest relative, *Sorex vagrans vagrans* of the humid strip along the Pacific Ocean, by several miles of upland which is inhabited by *Sorex californicus californicus*. According to the strict requirements of Wagner's hypothesis, the ranges of the most closely related forms should occupy adjoining territory. If our interpretation of the relationship of these forms be correct, *Sorex californicus californicus* must be conceived of as having invaded the territory it now occupies at the expense of the *vagrans* stock, crowding the latter to one side or the other.

Island distribution offers many cases of broad gaps between the ranges of species most closely related, but in most cases these gaps were formerly nonexistent or else the closely related stocks in question formerly enjoyed some means of transversing them, or are able at long intervals still to traverse them, though not to the extent that there is a quashing of incipient differential characters through interbreeding. The same principle should be remembered in connection with distribution along mountain systems like the Sierra Nevada, where, for instance, the family Ochotonidae has a discontinuous distribution, being found only in certain "islands" of high Boreal.

Two very interesting and instructive cases are furnished by the *maniculatus* series of mice. The relations between *Peromyscus maniculatus gambelii* and *Peromyscus maniculatus rubidus*, as well as those between *Peromyscus maniculatus austerus* and *Peromyscus*

maniculatus oreas, are rather exceptional. Concerning the first case Osgood says (1909, pp. 69, 70):

> The transition from *gambeli* to *rubidus* along the line between their ranges is rather sudden, suggesting the possibility of hybridizing. From several localities specimens fairly typical of both forms are known, from others we have both forms and apparent intermediates, and from still others all specimens thus far obtained are intermediate not typical of either form. This is exactly what would be expected upon the theory of hybridism, but of course it cannot be considered as conclusive proof.

Concerning the second he says (pp. 52, 53):

> The case is very similar to that of *gambeli* and *rubidus* in California, the complications of which may be due either to hybridization or to intergradation. It is already known that *oreas* and *austerus* occur together at a number of localities and apparently maintain their respective characters. At other places only one form has thus far been found, at others extremes of both forms and intermediates occur, and at still others intermediates only. There is no environmental distinction as in the case of *gambeli* and *rubidus*, for *oreas* and *austerus* live under apparently identical conditions. Although only one form has been found at the respective type localities of *oreas* and *austerus*, both occur together near by, and further collecting may show that they do so over a wide area. Specimens which appear to be intermediate between *oreas* and *austerus* may in reality represent special differentiations of the one or the other showing accidental parallelism.

These cases are very puzzling, as the pairs of species mentioned are very closely if not most closely related to each other, and on Wagner's hypothesis should not occur together. Note should be made of at least two possible explanations: It may be that, having originated in different geographic areas, and having undergone some degree of differentiation, there has been re-invasion, and that, even though very closely related, they occupy slightly different ecologic niches, and are able to coexist in the same place because of some measure of physiological isolation. Or it may be that we have here an illustration of Mendelian inheritance in nature, the two subspecies crossing freely. The extreme rarity among higher vertebrates of this latter type of behavior where ranges overlap at their margins, would seem to constitute an argument for the first, rather than the second explanation, but the case is not entirely clear.

It will be remembered that *Mustela arizonensis* is found in the Transition and Boreal zones of the Sierra Nevada and the Rocky Mountain systems. On the Cascades and the Trinity Mountains its place is taken by *Mustela saturata*, a closely related form. Between the Sierra Nevada and the Rocky Mountains there would

seem to be a barrier far greater than that between the Sierra Nevada and the Trinity-Cascade mountains, and yet *Mustela arizonensis* is found on both the Rocky Mountains and the Sierra, but is replaced by another species on the Trinity-Cascades! It may be, of course, that the real efficacy of the Klamath River gap has not been appraised at its true value, and that the effectiveness of the barrier between the Rocky Mountains and the Sierra has been exaggerated.

Mephitis platyrhina, as previously stated, is found in the Sonoran valleys around the south end of the Sierra Nevada. This species might be conceived to have arisen through mutation, or Darwinian divergence, or physiological selection, from *Mephitis occidentalis holzneri,* the range of which partially overlaps the range of *platyrhina.* The following considerations, however, militate somewhat against these possibilities: (1) The speciation, that is, differentiation, of the skunk family as a whole seems to have been dependent on migration and geographical isolation. (2) The overlapping of the ranges of *M. platyrhina* and *M. o. holzneri* takes place over a narrow area only. (3) *M. platyrhina* seems to be most closely related, on the basis of its structure, to *M. o. major,* which occurs to the northward, and not to *M. o. holzneri* (Howell, 1901, p. 39).

One other case: There occur along the Pacific Coast three species of the mammalian genus *Aplodontia,* very intimately related one to the other, less intimately related to the members of the genus found in the interior mountains (*Aplodontia californica* and *A. chryseola*). The coast species referred to are *Aplodontia pacifica,* Yaquina Bay, Oregon; *Aplodontia nigra,* Point Arena, California; and *Aplodontia phaea,* Marin County, California.

In the case of these forms the Sierran or mountain stock has evidently moved westward into the Siskiyou and Trinity mountains, where it is represented by the species *chryseola,* and even to the coast itself, where it is represented, in the Humboldt Bay region, by an undescribed form nearly identical, cranially, with *chryseola.* Thus the ranges of the closely related *A. pacifica* of Oregon and *A. nigra* of Point Arena, California, are separated by the *chryseola* stock, which must thus, on the Wagnerian hypothesis, be thought to have carried the western boundary of its range to the sea since the *pacifica-nigra-phaea* stock attained its broad coastwise distribution.

It is noteworthy that in all these critical cases there is not a sufficient quantity of fossil and Recent material for the adequate elucidation of their relationships. This is especially apparent with the weasels, skunks, and aplodonts just cited. On the other hand, in cases where material is abundant and the status of the forms is reasonably well established, the great mass of facts of distribution harmonizes with Wagner's theory.

How Have Different Ecologic Niches Been Filled?

It should be remembered, of course, that had living forms not possessed the power of adapting themselves or becoming adapted to different ecologic niches we would not have had the various niches filled. But the evidence from mammals and higher vertebrates would seem to indicate that geographic isolation is prerequisite to any kind of differentiation; physiological isolation, or practical sterility, being gradually assumed in proportion as the completeness and long continuance of geographical isolation, and the association of it with diversity of external conditions, permit or condition morphological changes extending to the reproductive system. The broader the distribution of the species and subspecies of any group of mammals or higher vertebrates, the greater the probability that some of the forms will find themselves in ecologic niches which, while they resemble in a general way the original group niche, will still differ from it in some important particulars. In strict terms, no two ecologic niches, situated in different geographic areas, can be precisely the same.

Thus it may be noted that while the so-called *panamintinus* group of the genus *Perognathus* occupies the same *general* ecologic niche wherever found, as a matter of fact, the particular ecologic niche occupied by each species or subspecies is somewhat different from that occupied by any of the other species or subspecies. Grinnell and Swarth (1913, pp. 390, 392) have listed in their "fourth category", Table D, a number of forms of birds and mammals of which also this may be said to be true, and in the opinion of the writer study of group distribution in vertebrates shows this to be a rule of practically universal applicability.

The status of things may be graphically represented by a diagram, as in fig. Q. Let the capital letter stand for the stock or species, the lower-case letter represent the ecologic niche it occupies, and the arabic numeral the geographic area in which the ecologic niche is

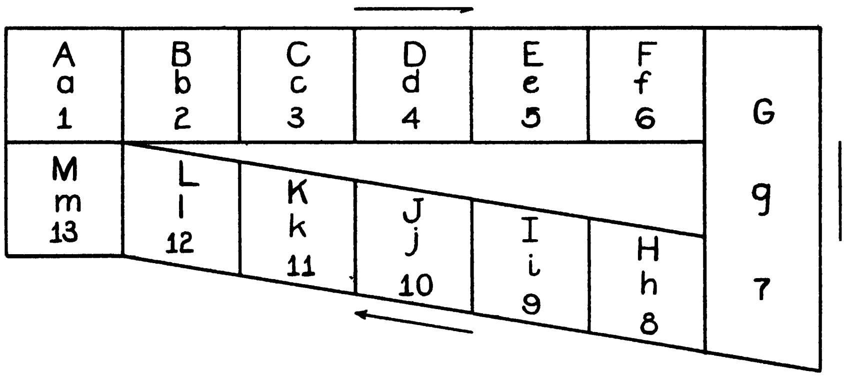


Fig. Q. Diagram illustrating possible explanation of presence of related forms in same locality.

located. The vertical lines represent geographical, the horizontal and slanting lines physiological barriers. Thus we have 1, 2, 3, 4 and so on, contiguous geographic areas, each separated from the other by some sort of geographic barrier. If A is the primitive mammalian stock, then B may be regarded as a stock which accidentally or otherwise has become geographically separated from it, and finally has become differentiated into a separate species. The continuation of this process of migration and differentiation may be conceived of as resulting in species G, which has become so far differentiated from the original stock A as not to be included in the same subgenus with it.

The ecologic niche *b,* occupied by species B, will be slightly different from niche *a,* in which the primitive stock is found. That occupied by species C will differ slightly from that occupied by B. This very slight difference in ecologic niche will be apparent up to and including *g,* in which species G, which has attained a quite considerable divergence, is found.

Thus the series of niches, into which members of the subgenus of which species G is representative will be able to enter, will be somewhat different from the series to which members of the subgenus of which species A is representative will have ready access. Thus it may happen, through a further continuation of the process of migration and differentiation, that species H to M, members of the G subgenus, may arise, and there may even be a re-invasion, on the part of some member of the G group, as for instance M, into the geographic area occupied by original stock A. But M will have

become considerably differentiated from A, and probably will be physiologically isolated from it, and furthermore, will not be under the necessity of competing with A, except in the most general way, for it will be fitted to occupy ecologic niche *m*, which is different from ecologic niche *a*. Two species derived from the same original stock will thus be found occupying different ecologic niches in the same place. The closest relatives of each will be found, not in the same locality but in a neighboring area, the races or species being kept separate by a geographic barrier of some sort. Thus B is A's closest relative, and L is M's closest relative.

It is to be doubted whether an actual series of cases completely illustrative of the steps in such a differentiation and re-invasion can ever be demonstrated in nature. The process is an extremely complicated one, as a moment's consideration will show. The diagram is purposely made very simple; in nature the process must be exceedingly complex. The primitive stock and its descendants are subject to all the vicissitudes of environmental and topographic change, and the process as above outlined would not only require an enormous time for its fulfillment, but would depend upon the existence of spatial relations of exactly the right sort. Possible contingencies in a great many directions are numerous.

The great weight of evidence from the study of mammals and higher vertebrates would seem to indicate that the occupation of different ecologic niches in the same place has in every instance been the result, not of some process of adaptation of a portion of the parent stock to a distinct ecologic niche, and the differentiation of this adapted portion while both were living in the same locality, but of some comprehensive process similar to the hypothetical one above presented, involving migration, differentiation, and re-invasion.

If, as we believe the evidence indicates, geographic isolation is, in the higher vertebrates, a condition essential to specific differentiation, then on the assumption that the classes of vertebrates are descended from one or a very few original stocks it follows that these migrations, differentiations and re-invasions have been very extensive. For there are many ecologic niches in almost every locality which are now occupied by various mammals, or birds, or reptiles. It has been long recognized, of course, that there have been numerous migrations and differentiations. But has due recognition been accorded the principles of invasion and re-invasion? Unless there had been, according to the logical continuation of the

two propositions (geographic isolation a condition to divergence in higher vertebrates; classes of vertebrates descended from one or a very few original stocks) extensive invasions and re-invasions, each geographical locality would now be occupied by one mammal, or one bird, or one reptile, only.

Following out this thought it would appear that there have been as many mammalian invasions or re-invasions for each locality as there are species or subspecies of mammals within it—unless so large a locality is taken as to contain barriers which would serve to isolate portions of the stocks from each other. This would seem to afford a confirmation from the standpoint of the theoretical necessities of isolation, of the axiom, stated by Grinnell (1914, p. 98) to be a necessary result of the ever-shifting location geographically of associational, faunal, and zonal conditions; this axiom is that "every single element or line of descent, now represented in the biota of any locality, must have come either in its present form or in some antecedent one from somewhere else."

In almost every locality there are ecologic niches which are unoccupied. In many instances there exist animals which could occupy these niches if they could get to them; but barriers of one sort or another effectually prevent their getting to them. This constitutes an important line of negative evidence which is complementary to the positive line. If an organic stock were capable of divarication in a single locality, given geologic time all occupiable niches ought to have been filled.

Of course the species resident in a locality might and probably would become modified monotypically through a progressively changing environment or from some other cause or causes, but there would never ensue any differentiation. To increase the number of species or subspecies of mammals in the locality further invasions or re-invasions are called for.

TENTATIVE SUGGESTIONS REGARDING THE MANNER IN WHICH GEOGRAPHIC ISOLATION ACTS IN THE PROCESS OF SPECIATION

Although in most cases laboratory work is done with forms low in the organic scale, and it is questionable how broadly the conclusions based upon such work may be applied, some of the results of experimental work are exceedingly suggestive as to what may be taking place in nature in widely separated classes of organisms. As Thomson says (1909, p. 329), "The world of organisms is very

large and heterogeneous, and results that hold good for certain forms of life may not be true of others." The variety of the living world seems to be no less characteristic than its unity; so it would seem appropriate that workers in science should be very chary of launching generalizations as universals.

Feeling, however, that one of the most pressing of present-day needs in biology is the correlation of the work of the "experimentalist" and the "naturalist", the writer is led to submit the following suggestions, incomplete though they may be.

When we face the question of the manner in which geographical isolation works, some of the results of Tower's experiments with beetles of the genus *Leptinotarsa* (1906) and of MacDougal's work with plants of the genus *Raimannia* (1906, p. 422) are of great interest. It will be remembered that Tower, by subjecting his beetles to varying conditions during the growth-period of the germ-cells, effected the production of new species and new characters. Although the parents were unaffected, their germ-cells were modified, and the offspring grew up different. MacDougal injected salt solution into the ovules of *Raimannia* just previous to fertilization, securing potentially new species as a result of the chemical and osmotic action exerted on unfertilized ovules. Tower, commenting on this case (1906, p. 295), says: "These results of MacDougal's exactly confirm in plants the results that I have obtained in these beetles, so that the point is now doubly certain that heritable variations are produced as the direct response to external stimuli."

Our studies of the distribution of higher vertebrates invite the belief that in the majority of cases differentiation follows migration and, clearly in most instances, the exposure to different environmental conditions. There is thus suggested a possible partial agreement between these two apparently widely sundered classes of observational facts. What has caused the differentiation which we observe in the higher vertebrates? The application of the principles of Independent Generation, Independent Variation, or *Amixia* (these three synonymous terms standing for differentiation under similar conditions in virtue of geographic isolation alone) to these classes of organisms is probably limited. These animals usually range so widely that there are obvious environmental differences associated with difference in species. The facts of geographical distribution of higher vertebrates do not militate against Tower's

conclusion that heritable variations are produced as a direct response to external stimuli, even if they cannot be shown directly to favor it.

It is noteworthy that Tower insists that although heritable variations are produced as a direct response to external stimuli, the response itself is absolutely determined within the organism. To quote his own words (1906, p. 295):

> It is true that different intensities of the same stimuli call forth different responses, but, as is shown in the chapter on coloration, the response is entirely determined within the organism, which is adjusted to different intensities of stimuli and reacts according to its own method and on the basis of its own constitution, there being no specific reaction called forth by a given stimulus.

The facts from the study of the zoogeography of the higher vertebrates appear to harmonize with these conclusions of Tower's. As the evidence becomes more complete it appears more and more clear that Darwin was right in assigning to the "nature of the organism" a more important place in considerations of speciation than that accorded the "nature of the conditions".

Do we not have here a suggestion as to how isolation works? The shaping of the species seems to depend upon two things primarily: (1) the nature, rapidity, and intensity of the blows from the environmental hammer; and (2) the nature of the organism itself. Thus isolation apparently operates, in the higher vertebrates, by segregating different sorts of environments and insuring their continued moulding of the particular segregated lots of individuals. On passing from one faunal area, association, or life-zone to another we encounter different, but closely related species. Thus differences between geminate species (Jordan, 1908) are apparently dependent upon the fact that differential environmental hammers have been used on what was originally the same stock. On making a comparison of this sort, we note that there has been great diversity of response on the part of the different members of the assemblage to the same environmental complex. The entire assemblage in any given district has been subject to the same environment, but the assumed differences in the stuffs moulded in each case readily account for the fact that all have not responded in the same way.

Tower (1906, pp. 286–296) found that by subjecting a given species of potato beetle to unaccustomed environmental stimuli there resulted in the offspring a break-up into several forms, some

of which resembled the parent stock and others of which exemplified potentially new species. For example, when *Leptinotarsa decemlineata* was so treated there was a break-up in the next generation into *Leptinotarsa immaculothorax, L. pallida,* and the unmodified *L. decemlineata.* The evidence from the zoogeography of the higher vertebrates clearly indicates, as has been repeatedly stated and implied, that isolation of one portion of a parent stock and subjection of it to the conditions of one new environment, results in the differentiation of but *one* new form, and that until further migration has effected the further isolation of the stock and its subjection to some other environment there is no further polytypic evolution.

A further implication contained in the work of Tower should be mentioned here. The modifications were definitely brought about in his experimental work through the action of the unaccustomed environmental stimulus during the period of growth and maturation of the germ-cells, and at no other time. This invites one to the suggestion that the environment may do its work by bringing pressure to bear directly or indirectly on the germ-cells, and that environmental-somatic impacts may be of no moment in speciation if they are not conveyed to the germ-cells. The failure of environmental-somatic impacts to be translated into environmental-germinal impacts may explain the permanence of subspecies amid conditions very different from those to which they are accustomed. *Ammospermophilus leucurus leucurus,* for example, having its center of distribution on the Colorado Desert, ranges notably over into the damper San Diegan faunal area, maintaining its desert characteristics even under the moister conditions (see Grinnell and Swarth, 1913, pp. 391–394). Evidently, however, such a translation of environmental-somatic impacts into environmental-germinal impacts has taken place in most cases in the past, and may perhaps be anticipated to take place, where it has not yet done so, at some time in the future.

As water, constantly dropping, wears away the stone, so the environment, through constant and continuous re-impression, seems to find at last some avenue to the germ-cell, until, as believed by most students of zoogeography, it becomes true that differentiation has come to be a part of the connotation of geographical isolation.

That the differentiation of which geographic isolation is a condi-

tion is cumulative, is indicated by a great many facts from zoogeography. Species known to have originated recently, as for example, those in neighboring areas separated by a barrier not absolute, are structurally much more alike than species known to have been separated for longer times. Thus *Castor subauratus shastensis* and *Castor subauratus subauratus*, occupying neighboring areas, and only recently separated, are structurally much more alike than are *Castor fiber* and *Castor canadensis canadensis* occupying areas in different continents, and separated for a much longer time. Island forms of mainland stocks are often poorly differentiated, the degree of divergence seeming in a measure to be associated with the length of time of separation of the island from the mainland. This cumulation is, of course, only within limits, for there are notable examples of very long separation with comparatively little differentiation, and even a few cases wherein long separation has apparently failed to bring about any differentiation whatever.

To summarize the remarks in this section: It may be conceived that isolation works with organisms in nature in some such way as the experimentalist works with organisms in the laboratory. The latter isolates a number of individuals and subjects them to a diversity of surroundings known as the conditions of the experiment. In nature the parent stock becomes separated, by some means or other, natural barriers corresponding to the walls of the container or of the laboratory, and the different environmental conditions in new territory occupied, corresponding to the conditions of the experiment. Differentiation may ensue in either case. In the higher vertebrates, at least, it has ensued practically in all cases. Geographical isolation probably conditions differentiation by segregating organism and environment together and maintaining their mutual interrelations over long periods of time.

Evidence from geographic distribution of higher vertebrates does not oppose, if it does not definitely support, the thesis that speciation is dependent on modification in germinal constitution. It appears to present unequivocal data that the response to the different environments depends upon the nature of the organism. It furnishes a mass of evidence against the theory of the possibility of the appearance of a new species in territory occupied also by the parent, so emphasizing the necessity of migration and geographic isolation as conditions of polytypic evolution. It indicates that

the differentiation conditioned by isolation is, within limits, cumulative.

As remarked previously, these conclusions are drawn up simply as a possible means of assisting in understanding the enormous and complicated body of facts concerning the speciation of the higher vertebrate animals, and may or may not hold for other classes of organisms.

SUMMARY

1. The ranges of seven recognizably differentiated subspecies of beavers touch upon, or lie close to, the Pacific Ocean in western North America.

2. Since beavers grow throughout their life, the consideration of changes in form, outline, and dimensions of the various parts due to difference in age becomes especially important. There is little change in coloration with age.

3. The beavers possess a highly specialized dentition, as is shown by the following facts: (1) the permanent dentition exhibits a high degree of hypsodonty, though the milk teeth are brachydont; (2) the enamel-fold pattern of the cheek-teeth is much complicated; (3) the dental formula is much reduced. The generalized mammalian formula is $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3} \times 2 = 44$, while that of the beaver is $I\frac{1}{1}$, $C\frac{0}{0}$, $P\frac{1}{1}$, $M\frac{3}{3} \times 2 = 20$. During ontogeny, the continuously growing cheek-teeth first increase in size, then decrease slightly. There are no important differences due to age in the proportional relation of the antero-posterior to the transverse diameter of the teeth. The dental armature is a cutting and grinding agency of high efficiency.

4. The similarly rounded instead of plane conformation of the palato-maxillary region, and the similar complication of the enamel pattern of the cheek-teeth in the Sciuromorph genus *Castor* and in the Hystricomorph genus *Erethizon* appear to be parallel adaptations: the first condition being an adaptation to the stripping of the bark from twigs and branches, the second to the effective mastication of this food.

5. Certain readjustments of current systematic conceptions of beaver status are necessary:

(1) The race of beaver inhabiting the Cook Inlet region of Alaska and ranging south into northern and central British Colum-

bia is here characterized as a new subspecies, *Castor canadensis belugae.*

(2) The race of beaver inhabiting the Pit River region of California, east of the Sierra Nevada, is here characterized as a new subspecies, *Castor subauratus shastensis.*

(3) The race of beaver inhabiting the mainland of Washington and Oregon is shown to be subspecifically distinct from the form on Vancouver Island (*Castor canadensis leucodonta* Gray) requiring the rehabilitation of Rhoads' name *pacificus.*

6. The fragmentary palaeontologic history of the Castoridae points to at least three intermigrations of beavers between the Old World and the New. *Steneofiber* appears in the middle Oligocene of Europe, and in the upper Oligocene of North America. The *Eucastor-Dipoides* stock appears in the upper Miocene of North America, and in the Pliocene of Asia. *Castor* first appears in the Pontian upper Miocene of Europe, but in North America it does not appear until later, its first known occurrence being in the Pliocene of California. In the case of each of these genera, at least one intercontinental migration is indicated.

7. The beavers of North America (those of which material has been available) are separable into two groups: the *canadensis* group, with subspecies *canadensis, michiganensis, belugae, leucodonta, pacificus, frondator,* and *texensis;* and the *subauratus* group, with subspecies *subauratus* and *shastensis.* The forms making up the *canadensis* group are unequally related.

8. On the whole, differentiation in the genus *Castor* is slight. The California stock has undergone more divergence than any other.

9. A consideration of its history and present status shows that the widest diversity of opinion as to the isolation concept still prevails, and emphasizes the necessity for more critical enquiries concerning it.

10. The evidence from beavers, and higher vertebrates generally, regarding Weismann's *Amixia,* Romanes' Independent Variability, and Gulick's Independent Generation, is inconclusive. In the case of beavers it must be conceded, however, that the possibility is by no means excluded that geographical isolation alone has been the chief condition in speciation.

11. The bulk of the evidence from the zoogeography of beavers and other vertebrates seems to indicate that polytypic evolution in these groups has been conditioned by the spatial partition of the

originally uniform stock as required by Wagner's isolation theory. If any one of the following factors, (1) "advantage of divergence" as Darwin used the term, (2) De Vriesian mutation, (3) Mendelian segregation, (4) physiological selection, has been operative in the differentiation of higher vertebrates, it is not apparent in the data of distribution. In these higher groups differentiation becomes, sooner or later, a part of the connotation of geographic isolation.

12. A corollary of the proposition just stated is that in beavers, and in higher vertebrates generally, geographic range is exactly as characteristic of species as any physical or psychical attribute.

13. Any definite conclusions regarding certain problematic cases would be premature. Much more testimony must be taken before a decision is reached. Such rare occurrences as that of *Peromyscus maniculatus oreas* with its closest relative *Peromyscus maniculatus austerus* in the same territory are susceptible of interpretation according to one of two alternatives: (1) the case may be one of speciation in accordance with Darwin's, De Vries', or Romanes' theories, the two species being preserved intact through Mendelian segregation; (2) the speciation may have proceeded according to Wagner's theory of geographic isolation (that is, by migration, geographical isolation, and differentiation); the physiological isolation between them may be but partial; and there may have been a re-invasion on the part of one into the range of the other.

14. Certain experimentalists, as Tower and MacDougal, have subjected parent generations of insects and plants to unaccustomed environmental stimuli, the offspring showing new characters and assumed to represent new specific types. The distribution of the higher vertebrates seems to make it certain that in the majority of instances differentiation follows migration, and, clearly in most cases, subjection to different environmental conditions. It looks as if in both cases heritable variations are produced as a direct response to external stimuli, the response in each case depending on the nature of the organism.

15. If this be the case, geographic isolation works no less by segregating different environments than by separating different lots of individuals. Stated differently, geographic isolation conditions differentiation through its maintenance of the mutual interrelations of organism and environment through long periods of time.

16. Zoogeography does not furnish evidence whether or not

the only effectual environmental impact is that which is received by the germ-cells; therefore it is not opposed to such a conclusion, already reached experimentally in widely different groups of organisms.

17. There is evidence from vertebrate zoogeography that indicates the cumulative character of the differentiation associated with geographic isolation.

18. The different ecologic niches in the same locality, so far as they are occupied by a given class of organisms, would seem to have been filled, not through processes of differentiation and adaptation in that single locality, but through those of migration, geographic isolation, differentiation, concurrent adaptation to different niches, and final invasion or re-invasion of the locality in question—to occupy different niches there. If geographic isolation is a condition essential to speciation in the higher vertebrates, and if each class of the higher vertebrates is derived from one or a few ancestral stocks, it follows that the tracing of these processes is highly important if not indispensable, either to an adequate understanding of the course of development of the class, or to a thorough conception of any particular facies of the class. Among these processes the principles of invasion and re-invasion, which are apparently of great significance in explaining the class-assemblage of a given locality, have been less emphasized than their importance deserves.

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LITERATURE CITED

Allen, J. A.
1877. "Castoridae" *in* "Monographs of North American Rodentia" *in* Report of the U. S. Geol. Surv. of the Terr., 11, no. 6, pp. 427-454.

Bailey, V.
1905. Biological survey of Texas. U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna, 25, 1-222, pls. i-xvi, 24 figs. in text.
1913. Two new subspecies of North American beavers. Proc. Biol. Soc. Wash., 26, 191-193.

Baker, M.
1906. Geographic dictionary of Alaska. U. S. Geol. Surv., Bull. 299 (ed. 2, Washington, Government Printing Office), 1-690.

Bangs, O.
1913. The land mammals of Newfoundland. Bull. Harvard Mus. Comp. Zool., 14, 509-516, 1 fig. in text.

BRANDT, J. F.
1855. Ueber die Kentnisse, welche die alten Perser, Egypter, Griechen und Römer vom altweltlichen Biber und den von ihm herstammenden Produkten besassen. Mém. Acad. Sci. Nat. St. Petersbourg, ser. 6, t. vii, abh. 4, cap. 1, pp. 78-87.

BRANDT, J. F., and RATZEBURG, J. T. C.
1827. Medizinische Zoologie (Berlin, Trowitzsch und Sohn), 1, 4 + 198, pls. 24.

CARY, M.
1911. A biological survey of Colorado. U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna, 33, 1-256, pls. 12, 39 figs. in text.

CHANDLER, A. C.
1914. The effect of extent of distribution on speciation. Amer. Nat., 48, 129-160.

CLARK, H. L.
1911. North Pacific Ophiurans in the collection of the United States National Museum. Bull. 75, U. S. Nat. Mus. (Washington, Government Printing Office), xvi + 302, 144 figs. in text.

CUVIER, F.
1821 and 1825.
In Saint-Hilaire et Cuvier's Histoire naturelle des mammifères. (Paris, 1819-35.) Not seen.

CUVIER, G. L. C. F. D.
1817. Le regné animal (ed. 1, Paris, 4 vol., avec 15 pl.). Not seen.
1825. Recherches sur les ossemens fossiles. (Ed. 3, 5 vols., Paris, Gabr. Dufour, 1825-26.) Not seen.

DARWIN, C.
1875. The origin of species. (New ed., from sixth English ed., New York, Appleton), xxi + 458.

DAVENPORT, C. B.
1903. The animal ecology of the Cold Spring sand spit, with remarks on the theory of adaptation. Dec. Publ. Univ. Chicago, first series, 10 (Chicago, University of Chicago Press), 157-176, 7 figs. in text.

DE VRIES, H.
1907. Plant breeding comments on the experiments of Nillson and Burbank. (Chicago, Open Court Publishing Co.; London, Kegan Paul, Trench, Trübner and Co., Ltd.), xvi + 360, 114 figs. in text.

DIXON, C.
1885.. Evolution without natural selection; or the segregation of species without the aid of the Darwinian hypothesis. (London, R. H. Porter), 1-80.

ELY, W. W.
1868. Differences between the European and the American beavers, *in* Morgan, The American beaver and his works (Philadelphia, Lippincott), 288-306, 3 figs. in text.

Gray, J. E.
1869. On the white-toothed American beaver. Ann. Mag. Nat. Hist., series 4, **4**, p. 293.

Gregory, W. K.
1910. The orders of mammals. Bull. Amer. Mus. Nat. Hist., **27**, 1-524, 32 figs. in text.

Grinnell, J.
1913a. The species of the mammalian genus *Sorex* of west-central California with a note on the vertebrate palustrine faunas of the region. Univ. Calif. Publ. Zool., **10**, 179-195, 6 figs. in text.
1913b. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., series 4, **3**, 1913, 265-390, pls. 15, 16.
1914. An account of the mammals and birds of the lower Colorado valley with especial reference to the distributional problems presented. Univ. Calif. Publ. Zool., **12**, 51-294, pls. 3-13, 9 figs. in text.

Grinnell, J., and Swarth, H. S.
1913. An account of the birds and mammals of the San Jacinto area of southern California. Univ. Calif. Publ. Zool., **10**, 197-406, pls. 6-10, 3 figs. in text.

Gulick, J. T.
1905. Evolution, racial and habitudinal. Carnegie Inst. Wash., publ. no. 25, xii + 270.

Heller, E.
1909. "The mammals" *in* Birds and mammals of the 1907 Alexander expedition to southeastern Alaska. Univ. Calif. Publ. Zool., **5**, 245-264, pl. 26, text figs. 3 and 4.

Hollister, N.
1913. A synopsis of the American minks. Proc. U. S. Nat. Mus., **44**, 471-480.
1914. A systematic account of the grasshopper mice. Proc. U. S. Nat. Mus., **47**, 427-489, with pl. 15.

Holmes, S. J.
1909. The categories of variation. Amer. Nat., **43**, 257-285.

Hopkins, A. C.
1914. Parallelism in morphological characters and physiological characteristics in Scolytoid beetles. Science, n.s., **39**, 187-188 (report of paper read before Biological Society of Washington).

Howell, A. H.
1901. Revision of the skunks of the genus Chincha. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, **20**, 1-47, pls. i-viii.

Jeffrey, E. C.
1914. The mutation myth. Science, n.s., **39**, 488-491.

Jordan, D. S.
1905. The origin of species through isolation. Science, n.s., **22**, 545-562.
1908. The law of geminate species. Amer. Nat., **42**, 73-80.

KELLOGG, L.

1911. A fossil beaver from the Kettleman Hills, California. Univ. Calif. Publ. Bull. Dept. Geol., **6**, 401, 402, 1 fig. in text.

1914. *Aplodontia chryseola*, a new mountain beaver from the Trinity region of northern California. Univ. Calif. Publ. Zool., **12**, 295-296.

KELLOGG, V. L.

1907. Darwinism today. (New York, Henry Holt), xii + 403.

KOFOID, C. A.

1907a. The limitations of isolation in the origin of species. Science, n.s., **25**, 500-506.

1907b. The coincident distribution of related species of pelagic organisms as illustrated by the Chaetognatha. Amer. Nat., **41**, 241-251.

KUHL, H.

1820. Beiträge zur zoologie. (Frankfurt am Main, Verlag der Hermannschen Buchhandlung), abt. 1, several unnumbered titlepages and Vorwort, then pp. 1-151.

LAMARCK, J.

1876. Zoologische philosophie. (German trans. by Arnold Lang; Leipzig, Ambr. Abel), xxiv + 511.

MACDOUGAL, D. T.

1906. The induction of new species. Science, n.s., **23**, 422.

MATTHEW, W. D.

1910. On the osteology and relationships of *Paramys*, and the affinities of the Ischyromyidae. Bull. Amer. Mus. Nat. Hist., **38**, 43-72, 19 figs. in text.

MEARNS, E. A.

1897. Preliminary diagnoses of new mammals of the genera *Sciurus*, *Castor*, *Neotoma*, and *Sigmodon*, from the Mexican border of the United States. Proc. U. S. Nat. Mus., **20**, 501-505.

1914. Descriptions of three new raccoons from the Mexican Boundary region. Proc. Biol. Soc. Wash., **27**, 63-67.

MERRIAM, C. H.

1895. Synopsis of the American shrews of the genus *Sorex*. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, 10, 57-100, pls. IV-XII.

1896. Synopsis of the weasels of North America. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, **11**, 1-45, frontispiece, pls. 5, 16 figs. in text.

1899. Results of a biological survey of Mount Shasta, California. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, **16**, 1-179, pls. I-V, 46 figs. in text.

1906. Is mutation a factor in the evolution of the higher vertebrates? Science, n.s., **23**, 241-257, 3 figs. in text.

MERRIAM, J. C.

1896. *Sigmogomphius lecontei*, a new castoroid rodent from the Pliocene, near Berkeley, Cal. Univ. Calif. Publ. Bull. Dept. Geol., **1**, 363-370, 2 figs. in text.

MICHAEL, E. L.
1913. The vertical distribution of the Chaetognatha of the San Diego region in relation to the question of isolation vs. coincidence. Amer. Nat., 47, 17-49.

MILLER, G. S., JR.
1912. List of North American land mammals in the United States National Museum, 1911. Bull. 79, U. S. Nat. Mus. (Washington, Government Printing Office), xiv + 455.

MORGAN, L. H.
1868. The American beaver and his works (Philadelphia, Lippincott), pp. i-xvi, 17-330, 23 pls., 26 figs. in text.

OSBORN, H. F.
1910. The age of mammals in Europe, Asia and North America. (New York, Macmillan), xvii + 625, 220 figs. in text.

OSGOOD, W. H.
1907. Some unrecognized and misapplied names of American mammals. Proc. Biol. Soc. Wash., 20, 43-52.
1909. Revision of the mice of the American genus *Peromyscus*. U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna, 28, 1-285, pls. i-viii, 12 figs. in text.

PREBLE, E. A.
1899. Revision of the jumping mice of the genus *Zapus*. U. S. Dept. Agric., Div. Biol. Surv., N. Amer. Fauna, 15, 1-42, pl. 1, 4 figs. in text.

RHOADS, S. N.
1898. Contributions to a revision of the North American beavers, otters, and fishers. Trans. Amer. Philos. Soc., n.s., 19, 417-439, pls. XXI-XXV.

RIDGWAY, R.
1912. Color standards and color nomenclature. (Washington, D. C., published by the author), iv + 44, 53 colored pls.

ROMANES, G. J.
1886. Physiological selection: an additional suggestion on the origin of species. Nature, 34, 1886: Aug. 5, pp. 314-316; Aug. 12, pp. 336-340; Aug. 19, pp. 362-365.
1897. Darwin and after Darwin, an exposition of the Darwinian theory and a discussion of post-Darwinian questions. Vol. 3, Isolation and physiological selection. (Chicago, Open Court Publishing Co.), viii + 181, frontispiece.

SCOTT, W. B.
1913. A history of land mammals in the Western Hemisphere. (Macmillan, New York), xiv + 693, frontispiece, 304 figs. in text.

SHELFORD, V. E.
1913. Animal communities in temperate America as illustrated in the Chicago region. (Univ. Chicago Press), xiii + 362, 9 diagrams, 306 figs. in text.

SPILLMAN, W. J.
1909. The nature of "unit" characters. Amer. Nat., 43, 243-248.

TAYLOR, W. P.
1911. Mammals of the Alexander Nevada expedition of 1909. Univ. Calif. Publ. Zool., 7, 205-307, 2 figs. in text.
1912. The beaver of west central California. Univ. Calif. Publ. Zool., 10, 167-169.
1914. The problem of aquatic adaptation in the carnivora, as illustrated in the osteology and evolution of the sea-otter. Univ. Calif. Publ. Bull. Dept. Geol., 7, 465-495, 15 figs. in text.

THOMSON, J. A.
1909. Heredity. (New York, Putnam's, London, Murray), xvi + 605, 49 figs. in text.

TOWER, W. L.
1906. An investigation of evolution in chrysomelid beetles of the genus Leptinotarsa. Carnegie Inst. Wash., publ. no. 48, x + 321, 30 pls., 31 figs. in text.

WAGNER, M.
1868. Die Darwin'sche theorie und das Migrationsgesetz der Organismen. (Leipzig, Duncker und Humbolt), viii + 62.

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TWO NEW APLODONTIAS FROM WESTERN NORTH AMERICA

BY
WALTER P. TAYLOR

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The genus *Aplodontia* is found west of the Sierra Nevada–Cascade mountain system from southern British Columbia on the north to middle California on the south. Study of specimens of the genus from the northern part of the range demonstrates the existence there of two subspecies hitherto unrecognized. The writer desires to express his thanks for the loan of material to the authorities of the Field Museum of Natural History, especially to Mr. Wilfred H. Osgood, to those of the Museum of Comparative Zoology, particularly to Messrs. Samuel Henshaw and Outram Bangs, and to those of the Bureau of Biological Survey of the United States Department of Agriculture, especially to Messrs. H. W. Henshaw and E. W. Nelson. He is also indebted to the authorities in charge of the Museum of Comparative Zoology, particularly to the director, Mr. Samuel Henshaw, for the privilege of describing a new subspecies of *Aplodontia* on the basis of material loaned.

Aplodontia rufa grisea, new subspecies

Puget Sound Mountain Beaver

Type.—Female adult, no. 3751, Mus. Vert. Zool.; Renton [near Seattle], Washington; October 4, 1907; collected by Frank Stephens; orig. no. 294; stuffed skin, with skull and jaws, all in good condition, except hamulars broken.

Diagnosis.—Similar to examples of *Aplodontia rufa rufa*, but paler, grayer; separable from *Aplodontia rufa olympica* through ab-

sence of distinct postorbital processes on the jugal; smaller than *Aplodontia californica columbiana* and *Aplodontia californica rainieri*.

Comparisons.—In examples of *Aplodontia rufa grisea* the brown coloration ranges from light ochraceous-buff to light buff, while in *A. r. rufa* the range in coloration is from near tawny to light ochraceous-buff; *grisea* for the most part lacks the distinct brown wash so often present in *rufa*. Cranially, *grisea* tends to have interpterygoid fossa narrower than in *rufa*, audital tube of smaller caliber, postorbital process indicated on the jugal in some specimens, and lesser mastoid width.

Aplodontia rufa grisea may be separated from *A. r. olympica*, in the usual instance, only by the different development of postorbital process on the jugal. In *grisea* these processes are weakly indicated in a few examples, in *olympica* they reach their maximum of development in the genus. Even this character cannot always be relied upon as certainly separative, since the postorbital processes are sometimes weakly developed in *olympica*. Available skins of *grisea* and *olympica* are not strictly comparable, for the majority of the specimens of *grisea* were collected in winter, and the series of *olympica* was taken in summer. Seasonal variation in the genus is usually exceeded by individual variation, however, so cross-comparisons may perhaps legitimately be made. A summer skin of *grisea* from Sumas, British Columbia (no. 88008, Biol. Surv. Coll.), is identical in coloration with certain summer specimens of *olympica*. Comparison of this skin with the entire series of examples of *olympica*, however, demonstrates the presence of more blackish dorsally in the latter and more of a tendency toward a brown wash ventrally.

Aplodontia rufa grisea is smaller than *Aplodontia californica columbiana* in both external and cranial characters, with slighter tendency to whitish ventrally; tendency for zygomatic and mastoid widths to be more nearly equal, lesser tendency to accentuation and approximation of temporal ridges, and incisive foramina tending to be shorter. From *A. c. rainieri*, *grisea* is separated by smaller size and by having basilar length averaging less, maximum length of nasals in *grisea* about equal to minimum in *rainieri*, nasals tending to be narrower anteriorly and posteriorly, interpterygoid fossa averaging narrower, mastoid width of cranium averaging less, conformation of rostrum more plane.

Material.—Fourteen specimens, as follows: one (no. 88008, Biol. Surv. Coll., taken by A. C. Brooks) from Sumas, British Columbia;

four (no. 94348, Biol. Surv. Coll., and nos. 6822, 6824, and 6825, Mus. Comp. Zool., all taken by A. C. Brooks) from Chilliwack, British Columbia; one (no. 6823, Mus. Comp. Zool., taken by A. C. Brooks) from Mount Baker Range, British Columbia; one (no. 7388, Field Mus. Nat. Hist., taken by L. M. Turner) from Ravenna, Washington; three (nos. 3749–3751, Mus. Vert. Zool., taken by Frank Stephens) from Renton, near Seattle, Washington; four (nos. 7385–7387, Field Mus. Nat. Hist., taken by E. C. Starks, and no. 3748, Mus. Vert. Zool., taken by Frank Stephens) from Seattle, Washington.

Measurements.—Of type (adult female): total length, 330 mm.; tail, 25; hind foot, 55; basilar length, 59.1; length of nasals, 26.7; width of nasals, 11.7; length of audital tube, 19.6; length of incisive foramen, 7.2; zygomatic width, 57.5; greatest width of interpterygoid fossa, 5.3; mastoid width, 52.5; alveolar length of superior cheek teeth, 19.6; distance between infraorbital foramina, 15.2; mandible, transversely across angular process, 22.3; greatest length of mandible, 49.5.

Remarks.—*Aplodontia rufa grisea* of the Puget Sound and Sumas districts is apparently nearest to *A. r. olympica* of the Olympic Mountain region. The characters of the Puget Sound form intergrade not only with those of *A. r. olympica* but also with those of *A. r. rufa* of the lower Columbia River.

Specimens referred to *Aplodontia rufa grisea* from Sumas, Chilliwack, and the Mount Baker Range, British Columbia, show tendencies toward greater dimensions in some respects, and are otherwise untypical, indicating a slight geographic variant in that region.

Although *Aplodontia rufa grisea* is not strongly marked at best, its relationships would seem to be indicated more accurately by its recognition as a subspecies of *rufa* than by its direct reference to that form.

Aplodontia californica columbiana, new subspecies

British Columbia Mountain Beaver

Type.—Male adult; no. 1899, Coll. E. A. and O. Bangs, Mus. Comp. Zool.; Roab's Ranch, Hope, British Columbia, June 14, 1894; collected by W. C. Colt; stuffed skin, with skull and jaws, in good condition, except skin with foreleg injured in trap, skull with left audital tube, region of foramen magnum, and hamulars somewhat injured.

Diagnosis.—Similar to *Aplodontia californica rainieri,* but larger; males having white patches beneath; nasals tending to be longer and

broader, zygomatic arches heavier and more expanded at posterior root, caliber of audital tubes tending to be less, a more pronounced tendency apparent toward approximation of temporal ridges, less of a hollow in skull outline dorsally (looking at skull in side view).

Comparisons.—In coloration dorsally *Aplodontia californica columbiana* is not conspicuously or appreciably different from *A. c. rainieri.* The tendency observable in males of *columbiana* to have irregular patches of white hair beneath is not expressed in available examples of *rainieri.* Total length externally is nearly 14 per cent greater in *columbiana,* figured on the basis of the total length in the type of *rainieri* and that in nine specimens of *columbiana.* The following cranial measurements average greater in *columbiana* than in *rainieri:* length and width of nasals, length of incisive foramina, zygomatic width, mastoid width, and greatest length of mandible. Available material shows the length of nasals in *columbiana* to be absolutely greater than in *rainieri.*

From *Aplodontia californica californica* the British Columbian form is distinguished, among other characters, by its larger general size, and by having, in the usual instance, zygomatic arches less square anteriorly, lighter in weight and more expanded in the region of the posterior root, caliber of audital tubes less, and external auditory meatus of different shape.

Comparison with *Aplodontia rufa grisea* is perhaps not strictly necessary. From this race *A. californica columbiana* is separated by the more pronounced tendency observable in *columbiana* to have irregular white patches beneath, by larger size in general, different outline of nasals, heavier zygomatic arches and their greater expansion posteriorly, lesser caliber of audital tubes, and different outline of external auditory meatus. The last-mentioned character is a conspicuous one, the meatus in *columbiana* being pinched up anteroposteriorly, making the dorsoventral diameter of the meatus greater than the anteroposterior. In *grisea* the outline of the meatus approximates a circle.

Material.—Nine specimens, all from British Columbia: four (nos. 1892–1895, Mus. Comp. Zool., taken by W. C. Colt) from Lake House, Hope; five (nos. 1896–1900, Mus. Comp. Zool., taken by W. C. Colt) from Roab's Ranch, Hope.

Measurements.—Of type (adult male): total length, 470 mm.; tail, 22; hind foot, 20; width of nasals, 13.0; length of incisive foramen, 7.8; zygomatic width, 66.0; mastoid width, 61.2; alveolar length

superior cheek teeth, 19.5; distance between infraorbital foramina, 16.6; mandible, transversely across angular process, 25.2; greatest length of mandible, 50.2.

Remarks.—*Aplodontia californica columbiana* is a strongly marked form, being in general the largest species of mountain beaver described up to the present time. It averages above the maximum in any other species or subspecies in length of nasals, zygomatic width, and, with only two exceptions, in mastoid width. In total length externally it averages decidedly above the maximum in any other race.

Although it is true that so far as at present known there are broad gaps between the geographic ranges of the three subspecies of *Aplodontia californica,* and that no intergradation between them has been demonstrated, nevertheless their mutual relationships as well as their status with reference to other forms of the genus would seem to be best shown by referring them all to this species.

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NOTES ON THE LOCAL DISTRIBUTION AND HABITS OF THE AMPHIBIANS AND REPTILES OF SOUTHEASTERN CALIFORNIA IN THE VICINITY OF THE TURTLE MOUNTAINS

BY
CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

A prominent feature in the topography of southeastern California is a chain of rugged hills known as the Turtle Mountains. These lie thirty miles west of Parker, Arizona (on the Colorado River), and extend north from the San Bernardino-Riverside county line for about forty miles. The author's survey of this particular part of the desert extended over a period of nineteen days, in May and June of 1914. In July, 1909, a day was spent at Goffs, a station on the Santa Fe Railroad thirty miles west of Needles, California, and about sixty miles north of Blythe Junction. At the latter point, on the Parker branch of the Santa Fe, six days were spent in June, 1914. At all these places especial attention was paid to the vertebrates. Altogether one hundred and thirteen specimens of reptiles and amphibians were

collected; these comprise twenty species. Habit notes were recorded at time of observation. The Turtle Mountain work was undertaken for the purpose of studying a definite fauna in an arid locality, where animal habitats are reduced nearly to simple topographical terms. (See map, pl. 19.)

All the specimens obtained have been added to the collection of the California Museum of Vertebrate Zoology, and it is under the numbers of this Museum that they are individually referred to in this paper. To the Director of this institution, Dr. Joseph Grinnell, the writer wishes here to express appreciation for criticism and general supervision during the preparation of the manuscript.

The color names used in this paper are taken from Ridgway's (1912) *Color Standards and Color Nomenclature*.

The desert bordering the lower Colorado River, its tributaries and distributaries, is not subject to the low winter temperatures prevalent in other continental parts of the United States, and it seems reasonable to suppose that this high winter (as well as summer) temperature might account for the greater number of species of lizards in the Colorado Desert than in the higher and colder Mohave Desert, the more enclosed and colder Death Valley region, and the plateaus of Nevada and Utah, farther north. Certainly the climate of the regions mentioned appears to differ in no other decided respect than in winter temperature, and this makes it seem likely that the latter must be reckoned as an important control in the distribution of saurians. Climatic characteristics of the Colorado Valley are: moderate winter and very high summer temperatures, during both night and day, scanty and sporadic rainfall, very low relative humidity and much air

CLIMATOLOGICAL TABLE

(Compiled from Bulletins L and W, U. S. Weather Bureau)

Locality	Altitude (feet) above sea level	Mean annual rainfall: inches	Mean annual rainfall: from	Mean annual temperature F.°	Mean relative humidity	Mean July temperature F.°
Yuma, Arizona	141	3.31	1870–1907	72.1	57% 8 a.m. 36% 8 p.m.	90.9
Parker, Arizona	375	4.12	1894–1907	71.0	....	92.5
Needles, California	477	3.49	1892–1908*	73.0	....	94.0
Mohave, California	2751	4.79	1877–1900	......	....	......
Mammoth Tank, California	257	1.99	1878–1908	76.0	....	98.5
Los Angeles, California	293	15.86	1878–1909	60.3	79% 8 a.m. 64% 8 p.m.	67.4

* There are at Needles only eleven days in the year on the average with .01 inches or more of rain.

movement, the last two resulting in a high rate of evaporation. Nowhere in the United States are lizards so numerous, both in species and individuals, as along the lower Colorado River.

The Turtle Mountains have never been surveyed. They rise to certainly not more than three thousand feet above the lowest surrounding depressions, the latter being about nine hundred feet above sea-level. At no points are their summits high enough to support the piñon and golden-oak associations such as occur on nearby desert mountains. Detrital materials washed from the slopes, and lying up against the hill-sides in great fans, nearly bury the lowest passes. In many places beds of brown scoriaceous rock cover the alluvial slopes and mountain sides. Farther out on the plains are stretches of gravelly ash peppered with lapillae. The scoriae are glossy and reflect much heat on bright days. Igneous rocks make up a large part of the mountain mass and there are a few eroded volcanic plugs, up to four or five hundred feet in diameter. Other formations occurring in some abundance are granites, quartz ledges, and, in the cañon bottoms, conglomerates; the latter, judging from their position, are of recent formation.

The hillsides are uniformly steep. They are covered with loose rocky material and retain but little soil. The cañon beds are boulder-strewn and often very narrow. At their mouths they are encroached upon by alluvial fans. These mesa-like benches are covered with scoriae, or with smooth pavements of flat pebbles, and show little soil on the surface. The arroyos dissecting the mesas are uniformly broad and sandy, giving evidence of copious, even though rare, floods. Undercut caves in the solidified gravels of the wash banks are frequently present at various levels above the wash floor. These holes furnish homes for the rough-scaled lizards and the desert wood rats (*Neotoma*), the latter industrious rodents being responsible for loosely piled accumulations of stones and dead twigs in and about the caves (see pl. 21, fig. 5).

The typical desert plains vegetation is not supported on the leached sand of the washes, which, probably because it is poor in nitrogen, has a distinct flora of leguminous plants such as palo verde (*Cercidium torreyanum*), smoke tree (*Dalea spinosa*), and ironwood (*Olneya tesota*). On the gravelly surface of the plains grows that most abundant of all desert plants, the creosote bush or greasewood (*Larrea tridentata*). Wash deltas and gentle slopes lying above 2000 feet in elevation usually bear, in addition to the creosote, stands of the long-

leafed tree yucca (*Yucca mohavensis*), a smaller species than the twisted form so common on the western stretches of the Mohave Desert.

Long belts of drifting sand traverse the California deserts at various places. These obviously owe their geographic position to the prevailing direction of wind, in connection with the place of occurrence of original stream deposits. Running east and west two miles south of Blythe Junction is a wind-drifted strip of fine sand blown into small dunes that are being carried eastward across the desert. In places this eolian material has been driven up over mountains and forms white cascades down their eastward slopes. The flora of the dunes south of the Turtle Mountains is dominated by a large species of *Ephedra,* or desert tea, and bunches of the wiry "galleta grass."

The plant and animal associations (see Ruthven, 1907, and Grinnell, 1914) in the region under discussion can be definitely correlated with the terrain, and the two together may conveniently be classed as *environments*, of which the following eight, at least, may be recognized in this region (see pl. 19).

(1) The rocky hillside environment, characterized by the low, pale, rounded shrub *Encelia,* and a small species of *Ephedra.*

(2) The cañon-bed environment, with the green catclaw (*Acacia*) as its most typical plant.

(3) The rocky mesa environment, possessing few species of either plants or vertebrate animals.

(4) The wash-bed environment, which is a direct continuation outside the mountains of the cañon bed and is in general slightly below the level of the rocky mesa. The characteristic association of leguminous desert trees lives in this environment.

(5) The low plain environment, distinguished by the predominance of the creosote bush (see pl. 20, fig. 3).

(6) The high plain environment, with the tree yucca, in addition to the low plain flora (see pl. 20, fig. 2).

(7) The drifting-sand environment, supporting a large *Ephedra* and patches of galleta grass (pl. 21, fig. 4).

(8) The cañon spring environment, represented in this region only by the three or four permanent springs of the Turtle Mountains, and characterized by the hydrophilous arrowweed association.

The water-supply, except after the rare showers, is extremely scanty. Behind dykes in three or four of the larger cañons feeble but lasting springs issue from the wash gravel. At some times of the year water can be found under the sand, or exposed in "tanks," pot-

holes hollowed out of the rock by stream action, and shaded by surrounding cliffs.

The desert terrestrial animals are for the most part independent of water; those apparently needing it, during the summer at least, are: coyotes, foxes, badgers, bob-cats, bighorn, and quail. The animals which fly to the water holes are perhaps more numerous, and include the bats, most birds, bees and wasps.

The following table indicating the environmental distribution of reptiles in the Turtle Mountain vicinity shows how sharply marked in

TABLE TO SHOW HABITAT LIMITATIONS OF AMPHIBIANS AND REPTILES IN THE TURTLE MOUNTAIN REGION

	Environments with characteristic plants							
Species	Rocky hillsid [*Encelia*]	Cañon bed [*Acacia*]	Rocky mesa	Wash bed [P verde and smoke tree]	Low plain (1000–2000 [Creosote bu	High plain (2000–3000) [Tree yucca]	Drifting sanc [*Ephedra*]	Cañon spring [Arrowweed]
1. Bufo punctatus	....	....	....	....	....	....	....	X^{46}
2. Testudo agassizii	x^{2}	x^{1}	....	....	....	xx^{7}	....	....
3. Dipsosaurus dorsalis	....	....	....	xx^{4}	x^{2}	x^{1}	x^{2}	....
4. Uma notata	....	....	....	....	....	....	X^{20}	....
5. Callisaurus ventralis ventralis	....	?	xx	X	X	X	x^{1}	....
6. Crotaphytus collaris baileyi	X	xx	x^{2}	....	....	....	....	....
7. Crotaphytus wislizenii	....	....	x	xx	xx	xx	xx	....
8. Sauromalus ater	X	xx	x^{1}	....	....	....	....	....
9. Uta stansburiana elegans	X	X	X	x	x	xx	....	....
10. Uta graciosa	....	....	....	x^{2}	x^{3}	x^{1}	xx^{4}	....
11. Sceloporus magister	x^{2}	xx	....	x^{1}	?	?	....	....
12. Phrynosoma platyrhinos	....	....	x^{1}	x^{1}	xx^{3}	?	....	....
13. Xantusia vigilis	....	....	....	....	....	x^{1}	....	....
14. Cnemidophorus tigris tigris	X	X	....	X	X	X	X	....
15. Sonora episcopa	x^{1}	....	....	....	....	....	....	....
16. Sonora occipitalis	....	....	....	....	x^{2}	....	?	....
17. Lampropeltis boylii	?	x^{1}	....	....	....	....	....	?
18. Bascanion flagellum frenatum	x^{2}	?	?	?	?	?	....	....
19. Crotalus cerastes	....	....	....	?	?	?	x^{1}	....
20. Crotalus mitchellii	....	x^{3}	?	x^{1}	....	....	....	....

NOTE.—Large crosses mean abundant; two small crosses, fairly common; one small cross, rare. Small numbers opposite crosses refer to number of individuals upon which the generalization is based. A question mark (?) means that these species occur elsewhere on the desert in this environment and *may* do so in the Turtle Mountain region.

most cases are the habitat preferences of these easily observed animals. An occasional species, like *Uma notata* and *Xantusia vigilis,* is restricted entirely to one kind of habitat, and no species, even though abundant, is known to range into every type of environment, although there are no apparent physical reasons why it should not do so. Theoretically, therefore, it may be possible for isolation to occur in a very limited region of well differentiated habitats and associations. This suggests interesting problems concerned with habitat limitations (see Grinnell, 1914, p. 102), and the separation of species and genera within a faunal area. Of the eight genera of iguanine lizards here represented only three range much beyond the limits of the arid Southwest. All are closely related and belong to a single group within the sub-family. Many of the differences between these genera seem to be adaptive and to be correlated with the differences in the nature of their habitats.

CHECK-LIST OF THE SPECIES OF AMPHIBIANS AND REPTILES OF THE TURTLE MOUNTAIN REGION

Little uniformity prevails in the use of vernacular names for most reptiles. Nearly all our species have several book names, and others are burdened with appellations belonging to more than one species. The matter might well be put into the hands of a committee appointed to edit the names that have been used, and to decide upon suitable ones, if vernaculars are not to be dropped from the literature altogether. The common names employed in the following list have been selected for descriptive appropriateness or because of long use. The authorities here followed in the adoption of vernacular names are Ditmars (1907), Grinnell (1908), Grinnell and Grinnell (1907), Meek (1906), Merriam *in* Stejneger (1893), Stone (1911), Van Denburgh (1897), and Yarrow (1882). Whenever a descriptive name could be found it has been employed; in a few cases vernaculars in the following list have not been used before.

1. **Bufo punctatus Baird and Girard. Spotted Toad**
2. **Testudo agassizii (Cooper). Desert Tortoise.**
3. **Dipsosaurus dorsalis (Baird and Girard). Desert Iguana.**
4. **Uma notata Baird. Ocellated Sand Lizard.**
5. **Callisaurus ventralis ventralis (Hallowell). Gridiron-tailed Lizard.**
6. **Crotaphytus collaris baileyi (Stejneger). Bailey Collared Lizard.**
7. **Crotaphytus wislizenii Baird and Girard. Leopard Lizard.**

8. Sauromalus ater Duméril. Chuckwalla.
9. Uta stansburiana elegans Yarrow. Desert Brown-shouldered Lizard.
10. Uta graciosa (Hallowell). Long-tailed Swift.
11. Sceloporus magister Hallowell. Rough-scaled Lizard.
12. Phrynosoma platyrhinos Girard. Desert Horned-toad.
13. Xantusia vigilis Baird. Desert Night Lizard.
14. Cnemidophorus tigris tigris Baird and Girard. Desert Whip-tailed Lizard.
15. Sonora episcopa (Kennicott). Texas Ground Snake.
16. Sonora occipitalis (Hallowell). Desert Burrowing Snake.
17. Lampropeltis boylii (Baird and Girard). Boyle King Snake.
18. Bascanion flagellum frenatum Stejneger. Red Racer.
19. Crotalus mitchellii (Cope). Pallid Rattlesnake.
20. Crotalus cerastes Hallowell. Sidewinder.

GENERAL NOTES ON THE AMPHIBIANS AND REPTILES OF THE COLORADO DESERT

The most common amphibians of the Colorado Desert are toads. Three hardy species of *Salientia* (*Bufo cognatus cognatus, Bufo alvarius,* and *Bufo lentiginosus woodhousii*) inhabit the Colorado River valley, and one other species, *Bufo punctatus*, though not known to be found along the river (south of the Grand Cañon), occurs in some of the desert springs, mountain cañons, and stream-beds (see (Stone and Rehn, 1903, p. 34, and Stejneger, 1893, p. 219). The Great Basin leopard frog, *Rana pipiens brachycephala,* also lives in and along the Colorado River.

Recent reptiles are represented on the Colorado Desert in California and Arizona by one species of tortoise, one gecko (*Coleonyx*), one night lizard (*Xantusia*), the "Gila monster" (*Heloderma*), one teiid (*Cnemidophorus*) and thirteen iguanine lizards, one blind snake (*Rena*), six colubrine and two crotaline snakes. A mud turtle (*Kinosternon*) occurs along the lower Colorado River. It might be noted here that Stephens (1914, p. 134) denies reports of the presence of "Gila monsters" in southeastern California. Neither is there any authentic record of *Holbrookia* or *Elaps* from California. The iguanine lizards include nine genera, the colubrine snakes five, and the crotaline snakes two. Among the genera of iguanine lizards are found herbivorous, carnivorous, omnivorous, insectivorous and myrmecophagous forms. Most species of desert lizards live on the ground among rocks or on sand and some spend their time in bushes and desert trees. In comparison with the lizards, the snakes of the Colorado Desert are few in number of individuals.

Glancing over the characters which distinguish desert reptiles we find that great power of locomotion is possessed by all but a few of the forms. The latter include the rattlesnakes and "Gila monsters," which have special means of protection, and the chuckwalla, gecko and night lizard, which seem to be restricted to habitats where they find immediately accessible retreats. The desert whip-tailed lizard, the gridiron-tailed lizard, the desert iguana, the ocellated sand lizard and the red racer all live in the open and forage at great distances from cover. The leopard lizard, probably the greatest runner of all, preys on other swift saurians, and the Bailey collared lizard does likewise. The latter, however, lives among the rocks where cover is always quickly available, and its agility is doubtless associated with its carnivorous habits. In many of the swifter lizards the tail is held above the ground and used as a counter-balance while running.

Loose sand characterizes one of the typical desert habitats. Many remarkable adaptations in the desert reptiles are developed or preserved by this kind of an environment. In the burrowing snake, *Sonora occipitalis,* in the gridiron-tailed lizard, in the ocellated sand lizard, and in the desert horned-toad, the rostrum is specially developed, protruding beyond the mouth. These reptiles *swim* into the sand by lateral movements of the head, and the lizards mentioned do not employ the fore feet in digging as does the *Cnemidophorus,* or whip-tail group. The eyelids of the burrowing lizards are fringed and meet tightly along thickened edges and the nostrils are collapsible. In the sand-loving desert horned-toad the ear opening is usually covered by the granular integument, while in other species of the same genus it is not.

The toes on both front and hind feet of the most characteristic American sand lizard, *Uma notata,* are broadened by a fringe of elongate scales, and in this respect parallel certain species native to desert regions in other parts of the world.

Keen vision and alertness are attributes of most desert lizards. In *Dipsosaurus, Callisaurus,* and *Uma,* alert lizards inhabiting open plains with sparse vegetation, the head is held aloft and the body is propped up on the fore limbs when the creature gazes about (see pl. 22, fig. 7).

The tail-dropping faculty of the species of lizards here discussed varies from almost perfect autotomy in the night lizard to entire absence of this function in the chuckwalla. The latter uses its tail as an organ of defense. *Cnemidophorus, Uma, Callisaurus, Uta, Scelo-*

porus, and *Dipsosaurus* are known to part with their tails, the first easily, the last with difficulty. In *Sauromalus, Crotaphytus* and *Phrynosoma* autotomy does not occur.

Notable in the case of many species, for example the desert horned-toad, the gridiron-tailed lizard, the ocellated sand lizard, and the side-winder, is the close resemblance between the color of the reptile as viewed at a little distance and the color of its surroundings (see Atsatt, 1913, p. 49; Stejneger, 1890, pp. 114–115; and Yarrow, 1875, p. 512). Color change in lizards may be seasonal, as in the orange-red nuptial colors of female *Uma, Callisaurus,* and *Crotaphytus wislizenii,* transitory, as the colors exhibited by the long-tailed swift when under excitement, or adaptive, as the dusky shades of gridiron-tailed lizards and horned-toads when found on dark soil (see in this connection Franklin, 1913, and Stejneger, 1890).

The femoral pores in lizards secrete a substance which seems to be of use during the breeding season. In many desert reptiles the period of greatest sexual activity, from April to July, is accompanied in the male by an abundance of the waxy secretion of these glands. Lizards in which a decided difference was found at this time of year between the size of the femoral pores in males and females were the chuckwalla, the rough-scaled lizard, the gridiron-tailed lizard, the long-tailed swift, the Bailey collared lizard, the ocellated sand lizard, and the desert whip-tail. The pores function most actively therefore in adult males during the early summer.

The daily and seasonal habits of desert reptiles seem to show some correlation with the distribution of the species. Those forms like *Dipsosaurus dorsalis, Uma notata, Sauromalus ater, Uta graciosa,* and *Crotalus cerastes,* which have ranges restricted to the hottest parts of the desert, may be seen abroad at all hours of the day during the summer and scarcely ever appear in the winter. *Uta stansburiana,* which is the only desert lizard ranging into the cooler Pacific coast district, is the last to be driven into cover by the cool of winter and the first to emerge on warm days.

It is reasonably certain that most, if not all, of the American desert reptiles do not require water.

ANNOTATED LIST OF THE AMPHIBIANS AND REPTILES

Bufo punctatus Baird and Girard

Spotted Toad

Forty-three larvae and recently metamorphosed young of a species of toad (no. 5539) are at hand from North Mountain Spring. I have available no comparable young of *punctatus* and so cannot be quite certain of the above identification of these young specimens. They are about half the length of *Bufo halophilus* of corresponding stage of development; they are broad-headed and dotted on the back with many small tubercles (red, in life) surrounded with indistinct black circles. The underparts are white and gray in alcohol (bronze-colored beneath, in life). The lower labial teeth in the tadpoles are in two long rows and one short one. The first of these (anterior), in the specimens examined, contained 126 teeth, the second 120, and the third 31 teeth. The comb-like upper lip is made up of from 55 to 65 solidly united teeth, and the lower lip of from 78 to 95 teeth (in three specimens examined). Total lengths, in millimeters, of nearly grown tadpoles: 25.4, 24.5, 23.0, 25.0, 25.0. Total lengths of recently metamorphosed young: 10.3, 9.7, 10.2, 10.5, 9.4.

The tadpoles were found on May 28 in a water-hole at the south end of the Turtle Mountains, five miles from any other spring and thirty miles from the nearest permanent stream. A search revealed some young toads huddled together in the crevices of planks about the pool, and some in wet sand nearby. The toads were active and apparently well fed, having an abundance of small flies to prey upon about the foul water. The sluggish tadpoles, swimming slowly to the surface of the murky, red pool were easily taken in the hand.

The sporadic occurrence of this amphibian in the driest of North American deserts is noteworthy.

Testudo agassizii (Cooper)

Desert Tortoise

Four tortoises were collected on July 20, 1909, at Goffs. None was seen at the south end of the Turtle Mountains, though their dens and broken skeletons were found there.

A large living specimen was obtained in 1908 at Mecca, Riverside County, California. It was said to have been taken in the Cottonwood

Mountains twelve miles northeast of the locality mentioned. This specimen was measured on February 23, 1909, and again on May 21, 1912. It was thirteen inches in length and had grown scarcely at all during these three years. It differed from the examples taken at Goffs in the color of the iris, which was yellow rather than brown as in the more northern examples. A desert tortoise was found near Victorville in April, 1906, and another at Barstow on March 16, 1914. In the Museum are additional specimens (nos. 3550 and 3609) from Kramer, San Bernardino County, and one-half mile east of Mohave, Kern County, California. A dead tortoise was seen three miles south of Palmdale, Los Angeles County, California, on July 24, 1914. Tortoises, though widely distributed, appear to be common at few places in the desert.

From what has been published concerning *Testudo polyphemus* of the southern states, a close relative of the desert tortoise, it appears that the most western North American species and the gopher tortoise of the East do not differ much in their general habits. Both live for the greater part of their lives in holes, both inhabit sandy or other loose soil suitable for the burrowing of their dens, and both dig their own refuges by the crude methods at their command. Like all known members of the genus, both are herbivorous.

About a mile north of Goffs station a number of desert tortoise burrows were found, some of which were occupied. The holes were dug slantingly into the rather firmly packed sand and gravel, usually at a grade of about forty-five degrees. Often the places chosen were under creosote bushes and in the banks of small dry washes. The tunnels were from two to eight feet long, with a slight widening at the bottom. They varied in diameter with the size of the tortoise that inhabited them, being in every case about the shape of a longitudinal, vertical section of the animal's shell. Sometimes the tortoise could be seen lying at the inner end of its burrow. In the deeper holes a stick thrust in would reveal the presence of the creature which, lying partly outstretched, would draw up its feet and head when it felt the touch; and this diminution of respiratory space beneath the shell would be accompanied by a noisy expiration like the rapid blowing of a bellows. When seized by the back of the carapace to be drawn out the tortoises would sometimes stick fast in the holes, hooking their crooked front legs into the sand. One deep burrow, otherwise empty, contained the broken halves of two white, hard-shelled eggs which appeared to have been spherical and about an inch in diameter. No brush or food of

any kind was found in any of the dens. Late in the afternoon of a hot July day a large tortoise was surprised in the act of coming out of its burrow. When it saw me it turned immediately and ambled back to safety.

Desert tortoises are said to come out in great numbers after thundershowers. But this is by no means the only time of their activity, for they appear to wander abroad at all seasons, frequenting rocky and uneven as well as level ground. One meets with them plodding steadily across-country, occasionally stretching their short necks down over the pointed extremities of the plastron and testing the ground with the sensitive tip of the snout or stepping aside to crop some small annual plant growing in the shade of a boulder. Their usual gait does not carry them along at a rate of more than four or five miles a day (twenty feet a minute by test), and they live at such great distances from water that in places it would seem impracticable for them to get a drink from one year's end to another. Sometimes when roughly handled a tortoise will void the contents of its cloaca and bladder. The foeces are black and about the size of those of the fox.

The author kept a number of desert tortoises at his home for a time in an enclosure out-of-doors. The captive tortoises paced their pens and frequently attempted to dig out under the fence. They were not able to burrow into hard ground, but in a gravel bank they would scrape away alternately with the fore limbs and when the hole became deep enough would turn around and push the dirt out with their shoulders. They grazed contentedly upon the lawn or in patches of green weeds, and also ate lettuce or cabbage leaves thrown to them. They were never active unless warm and seldom so even then, coming out in bright sunshine to lie outstretched or seeking the warmth of a stove or radiator in a room. They were handled a great deal and were never known to open their mouths to bite. They soon became used to human surroundings and would pursue their accustomed activities with people about. Some of their habits are worthy of notice.

When one tortoise meets another in the course of its journeying each, whatever the sex, nods its head rapidly up and down as if in salutation, and sometimes noses are touched before passing along. If two males happen to meet, a fight is likely to ensue. After the preliminary nodding the tortoises separate a little distance and then rush toward one another with the heads drawn part way into the shell. The combatants meet head on and the curved horns projecting from the anterior end of the plastron are butted rather violently against the

adversary, but do him no damage except sometimes to turn him upon his back; he may then struggle for some time with one fore leg vibrating vigorously in the air and the other pawing for a foothold in the ground before he can right himself.

The males court their mates by biting them gently around the edges of the shell. During copulation the male stamps his hind feet and utters a mechanical grunt with the head hooked over the end of the plastron and the mouth half open.

Stephens (1914, p. 135) writes that teeth marks are sometimes seen on shells of living tortoises and believes that the shells "generally prove too hard for the coyotes." The younger tortoises are soft-shelled and delicate. They probably fall prey in numbers to raptorial mammals and birds. The old ones are a favorite delicacy among Indian and Mexican section-hands who live with their families along the railroad lines. Some tortoises kept as curiosities at Needles on a grass plot in front of the Santa Fe hotel are thought to have been gradually depleted by the inroads of the Indians, many of whom lounge about the place.

Dipsosaurus dorsalis Baird and Girard

Desert Iguana

Four desert iguanas (nos. 5499–5502) were taken in the vicinity of Blythe Junction. In two specimens the rostral plate is separated from the nasals by one row of scales, and in the other two individuals by two rows. The femoral pores are 18 in two thighs, 21 in four, and 22 in one; being 18 right: 18 left once, 21:21 twice, and —:22 once.

The ground color varies slightly from light grayish to yellowish. One specimen has wide, brown reticulations enclosing lighter spots on the sides and back. A smaller example has narrow brown dots and dashes in place of the broad reticulations.

The total length of the largest individual is 360 millimeters; the tail is partly regenerated and measures 242 millimeters.

These round-nosed, large-tailed lizards are fairly common in the low plain environment in the sandy tracts south of Blythe Junction, and in the washes traversing the alluvial slopes about the Turtle Mountains. They appear to avoid rocky ground, being absent from the hillsides and mesas. They are shy when approached and run swiftly, with tail slightly raised, to the shelter of a bush, or into a chipmunk's or kangaroo-rat's burrow. When wounded they puff themselves up till

their sides become taut, and may then be pulled from a small hole only with difficulty. With curiosity aroused they prop themselves high on their fore limbs, attentively viewing the passer-by and seldom "showing off" with up-and-down movements of the body.

These lizards are phytophagous and may be sometimes surprised in the act of raiding the young leaves of low bushes, in the upper foliage of which they forage during the hottest part of the day. The stomach of a medium-sized individual contained two grams of the leaves and fruit of a malvaceous annual, *Sphaeralcea ambigua*.

Remains of a desert iguana were found below the cliff-side nest of a prairie falcon where, on June 6, 1914, two nearly grown young falcons set up a squawking chorus at my approach.

Uma notata Baird

Ocellated Sand Lizard

In the drifting sand two miles south of Blythe Junction, thirteen specimens of this extraordinary species were obtained (nos. 5444–5456). Some have the identical characters ascribed only to *Uma rufopunctata* by Cope (1900, pp. 279–281), while the smallest specimens are referable to *Uma notata* as described by Cope (1900, pp. 277–279) and Baird. It seems almost certain that the separation indicated is based on nothing more than individual and age differences. It appears also likely that the other two described species of this genus are but extreme variations of *notata*. Both *scoparia* and *inornata* were described from localities which lie within the probable range of *notata*, and in each case the type is the only known example. Three specimens at hand from Imperial County, California (doubtless near the type locality of *inornata*), have distinct spots on the belly and are not different from individuals in the Blythe Junction series. Most of the characters supposedly distinctive of *scoparia*, including the diamond-shaped dorsal scales and black dorsal spots, are expressed in individuals of the present series. The increased number of femoral pores in the type specimen of *scoparia* finds a parallel in individuals of other species of lizards and is probably also in this case not to be considered of systematic importance.

The femoral pores (including the accessory row) in the series collected near Blythe Junction number 25 in one thigh, 27 in one, 28 in one, 29 in three, 30 in four, 31 in four, 32 in four, 33 in one, 34 in four, and 35 in two; being ♂ 35 right: 35 left once, ♀ 34:34, ♀ 34:29,

♂ 33:31, ♂ 32:32, ♂, ♀ 31:32 twice, ♀ 30:34, ♂ 30:30, ♀ 29:31, ♀ 29:30, ♀ 27:28, and ♀ —:25. They are small in the eight females and medium-sized in the five males of the lot. In six cases they are in one and in seven instances in two rows. An accessory row is not present in the thighs with 25, 27, 28 and 35 pores, but is represented in most of the intermediate thighs and contains from one to three pores.

The supra-ocular rows of scales are 8 in one individual, 9 in five, 10 in five, 11 in one, and 12 in one. The loreal rows, counted where they join the line of the orbit, are 7 in six and 8 in seven specimens. The labials are strongly keeled; they number $\frac{7}{14}$ in one, $\frac{8}{13}$ in two, $\frac{8}{14}$ in one, $\frac{8}{15}$ in two, $\frac{9}{15}$ in two, $\frac{9}{16}$ in two, $\frac{10}{14}$ in two, and $\frac{10}{15}$ in one. The keeled suborbitals are 6–6 in one, 6–5 in two, 5–5 in four, 5–4 in one, 4–4 in two, 3–4 in one and 3–3 in one. The occipitals are separated from the small supra-oculars by 3 to 4 rows of scales. The scales on the outer edge of the gular fold are smaller than those in the middle, which in turn are larger than those on the throat. Ear lappets are 4 to 6. The points on the fringes of the lower eyelids are longer than those on the upper.

In all the specimens of the present lot a black spot from four to twelve millimeters in diameter is present on each side of the abdomen (see pl. 22); in some of the smaller specimens these spots are narrowly margined with green. In three the black markings on the throat are indistinct or reduced; in others two or three crescents and one to three V-shaped marks are present on the throat (see pl. 22, fig. 6). The black spots on the tail number 0 to 7; they are apparently not present on regenerated tail-tips and are never continued on the dorsal surface as in *Callisaurus*. Four of the smaller specimens are dorsally of the greenish *notata* type of coloration, with the ground color of the back of a pale greenish blue, near pale glaucous blue. Five of the intermediate examples are spotted with cinnamon on a background of greenish yellow, with the ocellations and brown crescents ascribed to *rufo-punctata;* and the four largest individuals (all males) are of the *scoparia* type of coloration, being covered with rich black ocellations' each bordered with a fine line, one scale wide, of orange-rufous. Each spot of light color is centered with a black dot, itself encircled by a narrow orange-rufous ring. The ground color is maize yellow. The eyelids and sometimes the sides of the head and tail in females are tinged with orange. One so colored contained three eggs, each 9 millimeters in diameter. Another contained one egg 18 millimeters long. Black spots are present behind both femurs in only two indi-

viduals and behind one femur in three; they are in all cases very small and obscure.

MEASUREMENTS IN MILLIMETERS OF *Uma notata* FROM NEAR BLYTHE JUNCTION, RIVERSIDE COUNTY, CALIFORNIA

Sex and number	5445 ♂	5452 ♀	5450 ♂	5449 ♀	5456 ♂	5454 ♀	5451 ♂	5453 ♀
Total length	215	181	193	172	201	180	202	139
Tail length	112	94	96	90	108	94	98	69
Body length	103	76	97	82	93	86	104	70
Hind foot	31	27	30	27	32	27	32	26
Base of 5th to end of 4th toe	27	23	26	22	27	24	27	20
Snout to ear	19	18	19	18	19	18	18	15
Head width	16	15	17	15	17	15	18	12

The ocellated sand lizard has so far been taken only at a few localities within a circumscribed area on the deserts of the southwest. It is strictly confined to belts of wind-blown sand, and in the vicinity of Blythe Junction was never seen beyond the borders of a narrow zone of sand dunes two miles south of the railroad. Many of these shy lizards were abroad in the hotter part of the day, scurrying over the fine sand, with a cloud of dust in their wake, or foraging beneath squaw-tea bushes on the dunes. Seldom was an individual taken unawares, and it was found difficult in most cases to approach an alert animal close enough for a successful shot with the .32 caliber auxilliary. Plate 22, figure 7, from an animal in captivity, shows the posture when fully alert.

The speed attained by these heavy lizards on loose sand is not so great as that of *Crotaphytus, Cnemidophorus* and *Callisaurus* in the same situations, despite the broadening fringe of scales on the toes. When alarmed they make for the nearest dune and turn behind it to enter a *Dipodomys* or *Citellus* hole or to bury themselves quickly in sand as the gridiron-tails do, the broad nose of which lizards their own shovel-like snout resembles. The tracks of the hind feet of a *Uma* running at top speed are five to six inches apart; and the deep imprints of these members indicate that most of the work is done by the hind legs, the fore limbs being merely used to balance the creature. The tail is curled upward while running, as in *Callisaurus*.

Their curious color patterns, though they may seem unduly striking when viewed in the specimen in hand, really harmonize in strong light with the buff tint of the sands, and the lizards are seldom detected until they begin to move.

One stomach was filled with a great number of ants. Another contained two grasshoppers entire, one large hemipter, eight red ants, two brown ants, two beetles, a pebble, and several pieces of vegetation. Another held seven brown and seven red ants, one beetle, several parasitic nematodes, and two fresh leaves and the terminal bud of a plant. One specimen when shot had a plant stem in its mouth.

Callisaurus ventralis ventralis (Hallowell)

Gridiron-tailed Lizard

Eighteen specimens of this abundant lizard were shot (nos. 5457–5474). All have four dark patches on the belly, two on each side, and are in other ways typical. The femoral pores are 12 in one thigh, 13 in one, 14 in four, 15 in six, 16 in six, 17 in eight, 18 in five, and 19 in three; being ♂, ♀ 19 right 18 left twice, ♀ 18:18 once, ♂ 17:19, ♂ 17:18, ♂ 17:16, ♂ 17:15, ♂ 16:17 twice, ♂ 16:16, ♀ 16:14, ♂ 15:17, ♂, ♀ 15:14 twice, ♂ 14:15, ♀ 13:15, ♂ 12:15 and ♂ —:17. Among the thirteen males five have large femoral pores, six have medium-sized ones, and two have small ones. All the five females have small pores. The males have large postanal scales, the females small ones.

In the examples before me the color above grades from pale smoke gray, with white on top of the head and white in spots down the back, to neutral gray with the usual dark dorsal markings. A specimen taken in the zone of drifting sand below Blythe Junction is the lightest of the lot, and some taken upon a mesa covered with brown lava are among the darkest of the specimens represented. It would appear that in this lizard, as in *Phrynosoma,* the tone of color is changeable in the individual to suit the surroundings. The throat is dusky in some specimens and light in others. There is a reddish spot behind the arm in the females. The females also all have pink sacs beneath the throat which are not "inflated," but are sometimes drawn down by muscles connected with the hyoid apparatus. The pink throat sacs are present in only three of the males in the series at hand. The underparts (with the exception of the two black wedges and the blue and green patches of the males) are white and not yellow as in specimens taken at Barstow, farther west. The tail bands number 4 in one, 6 in three, 7 in three, and 8 in eleven specimens. The anterior three or four of the ventral tail spots are sometimes entirely blue, and the posterior bands are often margined with blue below. Several of the largest males are nearly equal in length, but do not approach in size, individuals collected at Barstow in March, 1914. In the largest speci-

men from Blythe Junction (no. 5472), the total length is 194 mm., tail length 111 mm. A specimen from Barstow, San Bernardino County (no. 5385), is 223 mm. in total length, and 130 mm. in length of tail.

This lizard is abundant on the open desert around the Turtle Mountains. It does not occur on the rocky hillsides, and even in the sandy cañon bottoms is found but sparingly. It is on the open stretches of desert dotted with creosote bushes that this species is typically at home; and here it outnumbers all the other diurnal vertebrates combined. Individuals may be observed bobbing up and down, switching the tail from side to side, walking jerkily along with the tail curled over the back, or running with such speed that the eye can barely follow. The writer estimated that one of these swift lizards covered a distance of 90 feet in four seconds, which would be travelling at a rate of about fifteen miles an hour. The lizards can stop and start with the most confusing abruptness, and rarely run straight away but describe a circle when pursued. When tired out they may crouch close to the ground and will then permit themselves to be caught; or they may burrow into loose sand by wriggling the head from side to side and pushing with the hind feet while the front feet remain pressed close to the side. Sometimes when closely pursued they enter holes.

Of eight stomachs examined not one contained plant remains, the contents being insects, small pebbles, part of a shed lizard skin, and parasitic nematode worms. Perhaps, like some of the geckos, these lizards eat their own shed integument. The insects represented included eight Orthoptera, eight ants, and several small Coleoptera. Some of the grasshoppers and crickets were of large size (40 mm. long) and had been swallowed entire. These lizards sometimes spring a foot or more to seize a tempting bait; and I saw one, probably by mistake, leap over the edge of an eight-foot wash-bank while jumping for a grasshopper in a bush. At Blythe Junction a gridiron-tailed lizard was seen regularly at a certain doorstep picking up dead crane-flies and other night-flying insects thrown there by the housewife. The lizard apparently became so absorbed in picking up, shaking and swallowing the gauzy-winged flies that it many times permitted the observers to touch it lightly upon the back.

After sundown the gridiron-tail buries itself in sand, and when alarmed as by an approaching team or pedestrian will start up suddenly and dash away.

Some of the females taken in July contained eggs. Two eggs, 18 by 9 millimeters in the two diameters, were taken from one lizard; these had coriaceous coverings and were apparently ready to be laid.

Crotaphytus collaris baileyi Stejneger

Bailey Collared Lizard

Eight specimens (nos. 5480–5487) represent this form in the collection from the Turtle Mountain region. There are five males and three females, the former being readily distinguished by the large postanal plates. All have the interorbital scales in two distinct rows.

The femoral pores are 16 in three thighs, 17 in five, 19 in four, 20 in two and 21 in two; being ♀ 21 right: 21 left once, ♀ 20:20, ♂, ♀ 19:19 twice, ♂ 17:17 twice, ♂ 16:17, and ♂ 16:16. They are very small in the three females, medium-sized in three males, and large in two of the males. Stejneger (1890, p. 105) describes the color of a living Bailey collared lizard from the San Francisco Mountain plateau, Arizona. None of our specimens show strongly marked reticulations as do examples from farther east and north. All the females have faint indications of whitish cross-bars, and in them the black collar is not joined below the neck. The males have the collar connected ventrally, and the largest males show not a sign of dorsal cross-bars. The total length of the largest specimen, a male, is 310 millimeters, the tail length 214 millimeters.

These grotesque lizards inhabit the rocky slopes of the Turtle Mountains in numbers and live also among the rocks about the bases of the hills, but they were never seen on the open desert. This agrees with observations by Taylor (1912, p. 326) in northern Nevada. Like the chuckwallas, the Bailey lizards mount rocky eminences and lie for hours in the sun during the hottest part of the day. When approached they slip down into crevices or run with alacrity over the roughest ground, clearing obstacles up to two feet in height with great leaps. The males distend their dark throats when "showing off." They seem hard to kill, and when thought dead will sometimes "come to life" in the collecting sack, blinking their yellow eyes and looking ferocious. When under excitement the brilliantly colored throat is distended and the huge mouth is sometimes opened in anger. Coues (1875, pp. 598–599) has recorded interesting observations upon the habits of this species.

One stomach contained two chewed grasshoppers, and another three orthopterous insects, more or less chewed, and four small beetles.

Crotaphytus wislizenii Baird and Girard
Leopard Lizard

Six specimens of this species were secured (nos. 5488–5493) of which two are females and four males, the latter with large postanal scales. The femoral pores number 20 in one thigh, 22 in one, 23 in three, 24 in four, and 25 in three; being ♂ 25 right: 25 left once, ♂ 25:23, ♀ 24:24, ♂, ♀ 23:24 twice, ♂ 20:22. One of the females taken in July still displays the red nuptial coloration: the bars on sides of neck, back and hind legs (in ordinary coloration white or yellow) are peach red to scarlet; base and tip of tail beneath are shrimp pink. The ground color of this individual is light neutral gray on the lighter parts of the back; fuscous spots occur on the back and sides, with bands of the same color on the tail. A female (no. 5489) not exhibiting red coloration contained one large egg. A large male has scarcely a trace of the ordinary reticulation on the back, and the brown dorsal spots are reduced to small dots on the body and tail. The longest specimen, a male, has the following measurements: total length 364 millimeters, tail length 260 millimeters.

The leopard lizard, probably the swiftest of North American desert reptiles, was fairly common in the Turtle Mountain district at the time I was there. This species does not inhabit the rocky hillsides in that vicinity; unlike the Bailey collared lizard, it appears to haunt the more level plains and sandy places. Individuals are wary and take to retreats, often before it is possible to get a shot at them. The tracks of the hind feet of leopard lizards running swiftly in sand were found to be ten inches apart.

A grown gridiron-tailed lizard swallowed whole and head first was found in one stomach. The flabby sides of the leopard lizard are often distended with the remains of smaller lizards which they have run down and swallowed. Taylor (1912, p. 348) and Franklin (1914) have seen this species eat cicadas, leaping into the air to catch them.

Sauromalus ater Duméril
Chuckwalla

Chuckwallas were common on the rocky sides of gulches at the Hern Mine. Seven specimens were taken there, and one specimen in a level field of scoriae at Blythe Junction. These specimens (nos. 5518–5525) show considerable individual variation in width of head,

size of scales on side of neck, and coloration, but fall easily within the general range of characters given for this species. The femoral pores are much enlarged in the males and almost indistinguishable in the female, a condition holding in many other species of lizards of the locality in the early summer season when collecting was done. The femoral pores number 15 in one thigh, 16 in three, 17 in one, 18 in three, 20 in two, 23 in one, and 24 in one of the thighs, where counts could be made; being ♂ 23 right: 24 left, ♂ 20:20, ♂ 18:19, ♂ 18:16, ♂ —:18, ♂ 16:17, ♂ 15:16, ♀ —:—. One individual exhibits an accessory row of pores on each side.

Some of the specimens show a great amount of red on both dorsal and ventral surfaces and a few do not; some are banded on the tail and some exhibit scarcely a trace of this characteristic. In a young specimen there are around the tail four broad, encircling bands of brown alternating with three circles of yellow. An adult male (no. 5520) is colored as follows: top of head dark brown, nearly black, with many yellow scales scattered over the occiput and head and small patches of orange in the ear just behind the tympanum; back speckled with black scales in lichen-like pattern; about an equal number of orange and of yellow scales, evenly dispersed, covering most of back; shoulder patches large, dark brown, and dorsal surfaces of limbs dark brown; feet spotted with yellow; head and limbs beneath, black; belly almost uniform dark morocco to brick red; tail abruptly lighter than rest of body, deep colonial buff, faintly banded with three broad rings of deep olive buff. The measurements of the largest male are: total length 371 millimeters, tail length 198 millimeters.

This clumsy, vegetarian lizard is common on the rocky slopes of the Turtle Mountains and may occasionally be seen in the patches of scoriae out from the base of the range. It was never noticed elsewhere, and having rather feeble powers of locomotion, doubtless depends upon the security of the rocks to a greater extent than do swifter lizards. It lacks the curiosity of smaller species and loses no time in slipping to safety at the approach of danger.

Chuckwallas were seen perching on rocks so hot as to be unbearable to the hand, and big, gorgeously colored males were noted in pursuit of each other over hillsides in the middle of the hottest July days. In the latter part of June one pair, male and female, were seen near one another.

The chuckwalla has a curious habit of sticking out the fleshy tongue at every few steps when walking along. Like toads and

Phrynosoma, Sauromalus can be made to assume a rigid hypnotic posture by gentle rubbing on the belly. In this condition an individual may remain half an hour without moving.

The half-eaten body of a large female was picked up near a nest containing two young prairie falcons. When attacked in its retreats, the chuckwalla inflates itself and lashes the heavy stub-tail about vigorously. Aside from this it appears to be utterly innocuous, and the writer has never known one to attempt to bite even when handled roughly. Mr. Dane Coolidge states that the desert Indians, to whom the chuckwallas are a delicacy, puncture the lizards' sides with sharpened wire in order to deflate them and then draw them from their retreats among the rocks.

Old chuckwallas often have scars on the back caused perhaps by crawling about in crevices. One individual secured had lost the front foot on one side and the hind foot on the other, and in spite of its misfortune was lively and had a stomach full of food. One chuckwalla was seen up in a small creosote bush from which most of the leaves had been stripped. The three stomachs examined contained plant remains. In two cases the leaves were swallowed entire and belonged to a composite (*Franseria dumosa*) and a spurge (*Euphorbia polycarpa*) ; the other stomach contained many chewed leaves and stems.

Uta stansburiana elegans Yarrow

Desert Brown-shouldered Lizard

The present writer follows Richardson (1915, p. 473) in the use of the above name. The characters ascribed to *elegans* are exemplified fairly well in the nine specimens (nos. 1099–1100, 5526–5532) from the vicinity of the Turtle Mountains. The dorsal horizontal scale rows number 76 in two specimens, 82 in two, 84 in one, 85 in two, 86 in one, and 100 in one. The average number of rows is 84, and the error of numbering, as ascertained by repeated counts, is certainly not greater than 7 per cent. The average number of dorsal scale rows in six specimens of *hesperis* at hand is 100.6. These averages agree quite well with determinations by Richardson of 86.5 and 102 for the two subspecies *elegans* and *hesperis* respectively. Individuals of the two subspecies cannot always be separated by the number of dorsal scale rows alone. The present series of *elegans* is much bluer in dorsal coloration and smaller in size than in the large series of *hesperis* at hand. The femoral pores number 13 in three thighs, 14 in ten, and 15 in

four; being 15 right: 15 left once, 14:15 twice, 14:14 three times, 14:13, —:14, and 13:13. All have scattered bright blue scales over the back, and some are green along the sides. In one female the indigo patches in the axilla are almost entirely lacking. Both striped and spotted types of coloration are exhibited in the present series. The total length of the largest example, a female, is 139 millimeters, and the tail length is 89 millimeters.

The tiny desert brown-shouldered lizard occurs throughout all the environments of the Turtle Mountains district except in the tracts of eolian sand near Blythe Junction. It seems to be most common in the more rocky localities, particularly on the lava fields. Those taken on brown scoriae were noticeably bluer than those found elsewhere. The stomach of one individual contained several small ants and beetles, and one spider.

Uta graciosa (Hallowell)

Long-tailed Swift

Seven specimens of this arboreal lizard were collected (nos. 1102, 5533–5538), one at Goffs and six near Blythe Junction. These include five males and two females. All the males have large postanal plates and blue patches on the belly. The females do not possess either of these characters. The scutellation of the back in the present series is typical. The femoral pores number 10 in three thighs, and 11 in nine; being ♀, ♂, ♂, 11 right: 11 left three times, ♂, ♀ 11:— twice, ♂ 11:10, ♂ 10:10. The pores are large in the males only. The colors are rapidly changeable in life, as described below. A male in alcohol has the patches on the belly olympic blue in color, thickly flecked with white, and divided by a light line. Each white dot involves one scale. The sides are yellowish, and the back grayish with reticulations of dark gull gray. The alcoholic females are yellowish beneath. The largest specimen, a male, measures 181 millimeters in total length and 127 millimeters in tail length. A female measures in total length 168 millimeters and in tail length 114 millimeters.

A number of long-tailed swifts were seen in the vicinity of Blythe Junction. Some were in creosote bushes on the open desert, some in squaw-tea on the sand dunes, and some on the branches of smoke trees in the washes. They like to sun themselves on the topmost twig of a bush, hanging motionless and head downwards as though pinned there by a shrike. If disturbed they drop to the middle of the bush and

flatten themselves against a limb lengthwise, keeping on the side away from the intruder, their wiry tails stretched out stiffly in line with the body. When alarmed while on the ground they make for the nearest bush and jump up into it, there to dodge actively about among the branches, quite unlike their brown-shouldered relatives which usually retreat beneath stones or into holes when pursued. The species under discussion appears to be active at least till dark in the evening, and early in the morning, as well as in the middle of the day.

A pair was seen copulating on July 13, in the hottest time of the day. The two lizards were clinging to the inclined branch of a creosote bush and the female was colored for the occasion, being light orange with two longitudinal black stripes down the sides and a row of black lozenges down the center of the back. The male was grayish over the back and yellowish on the sides. The power of color change in these lizards is greater and more rapid than in any other Californian reptile. A nearly white male held in my hand changed rapidly in two or three minutes to yellowish with black cross bands on the back, the originally light greenish ventral patches became blue, and a yellow spot appeared under the throat.

I saw a female of this species swallow a large-winged insect it had picked up from the sand. The stomach of a male contained chewed plant stems and what appeared to be the broken shells of insect eggs. An elongate, white, tick-like parasite was seen affixed head downwards in the axilla of a long-tailed swift.

Sceloporus magister Hallowell

Rough-scaled Lizard

Five specimens (nos. 5475–5479) of this brilliantly colored lizard were taken. Four are males and one is a female. The femoral pores number 13 in five thighs, 14 in two, and 15 in three; being ♀ 15 right: 15 left once, ♂ 15:14, ♂ 14:13, ♂ 13:13 twice. The pores are small in the female and greatly enlarged in the males. The anterior auricular denticulations are long and tapering.

The coloration of the adult males varies a good deal, and this variation is especially noticeable in the vivid ventral colors. One male has the neck band pure black, the throat patch olympic blue of the sheen of porcelain, the darkest belly scales urania blue of a porcelain cast, and the scales laterally on the ventral patch variscite green to Blanc's blue. Many of the scales along the sides of the body are edged with

rufous and have brown centers. Scales on the sides of the tail are opaline green. The general color of the upper parts and the top of the head is deep olive buff to buffy brown. The scales of the dorsal surface are edged with dark brown. The ground color of the ventral surface is whitish.

The ventral patches are in three specimens divided and in one united. There are no indications of dorsal cross bands or spotting in any of the males. The female is marked dorsally with sixteen brown patches, about a scale in width. The lower surface is creamy white lightly tinted on scattered scales with pale greenish, pale orange and, beneath the throat, pale blue. The collar of the female is brown.

The largest male measures 266 millimeters and the tail length in the same specimen is 149 millimeters.

The rough-scaled lizard was only occasionally seen in the Turtle Mountain region. It lives in and beneath catclaw bushes, on boulders in the cañon bottoms, and in caves in the undercut wash-banks. In only one instance were any of these lizards noticed far from safe retreats. During the forenoon of June 2, while the ground was still damp from a recent thunderstorm, two large male rough-scaled lizards appeared at intervals on a bare hillside. An explanation of their unwonted fearlessness may have been that they were in an active sexual state.

A large orthopterous insect, somewhat chewed, a fly, a beetle, and several other insects were found in one stomach. Another stomach contained a grasshopper, a beetle, a lepidopterous insect, several small red ants, and some pebbles. A third contained a caterpillar, five Coleoptera, one hemipter, three small red ants, the fruit and green leaves of a small plant (identity uncertain) and a few dry leaves (perhaps taken accidentally).

Phrynosoma platyrhinos Girard

Desert Horned-toad

Five specimens of this species (nos. 5494–5498) were collected, including two females and three males; and these were all the horned-toads seen in the Turtle Mountain vicinity. The males can be distinguished at once by the large postanal plates. The ear opening is covered in all the above specimens. The femoral pores number 7 in three thighs, 8 in five and 9 in two; being ♂ 9 right: 8 left once, ♀ 8:9, ♂ 8:8, ♂ 7:8, ♀ 7:7. The red of the dorsal parts varies much among in-

dividuals, being light coral red in some and brick red in one, which latter also has the sides of the head, the horns, and the tail sprinkled with light red. The underparts are pure white, or else spotted with from 60 to 70 black dots. Red in the dorsal coloration occurs in both males and females. The total length of the longest specimen, a male, is 137 millimeters, and the tail length is 52 millimeters. Another male measures 122 millimeters in total length and has a tail length of 48 millimeters.

Desert horned-toads about the Turtle Mountains are occasionally seen in the sandy wash-bed and low-plain environments. They seem to be less frequent on the rocky mesas, and are wholly absent on the hillsides. Their activity in the hot season appears to be restricted to the morning and afternoon hours. When alarmed they often retreat to the shelter of an *Atriplex* or other low-growing bush, dodging about, when pursued, on the ground beneath the thickly matted lower branches (see Richardson, 1915, p. 423). One was found on an open mesa after sunset, appressed to a small brown piece of lava and apparently asleep. This individual was dark gray when discovered, but became very light in color the next day.

Phrynosoma platyrhinos seems to be a more agile species than *P. blainvillii* of the Pacific coast district in southern California. Bryant (1911, p. 16) interestingly describes the burrowing habits of *Phrynosoma.*

The examination of the stomach of a preserved specimen revealed four parasitic nematodes, six beetles, one orthopter, many black ants, a leaf, a seed, five pebbles and some gravel and earth. Contents of another stomach were: fifteen parasitic nematodes, six Coleoptera, one orthopter, 145 red-headed ants, all apparently of the same species and swallowed whole, and one pebble.

Xantusia vigilis Baird

Desert Night Lizard

The only specimen found (no. 1101) was taken near Goffs. It has 116 transverse and 38 longitudinal scale rows on the back. The frontonasals are joined on the median line, the frontal is entire, and the specimen seems identical with examples of *vigilis* from the western Mohave Desert. There are seven femoral pores on the right thigh. The color above is cream buff to chamois; slightly lighter below; faint

white lines on back of neck; back speckled with brown scales. Total length 86 millimeters, tail length 52 millimeters.

The specimen secured was found in the usual habitat of the species, under a prostrate tree-yucca branch in a small grove of *Yucca mohavensis*. The species is rare in this locality, which appears to be the eastern limit of its range. Unsuccessful search was made for night lizards among the rather scattering tree yuccas along the east base of the Turtle Mountains, five miles north of the Horn Mine.

Cnemidophorus tigris tigris Baird and Girard

Desert Whip-tailed Lizard

Fifteen individuals (nos. 5503–5517) of this forked-tongued lizard were secured in the vicinity of the Horn Mine and Blythe Junction. This series illustrates some phases of variation as pointed out by Gadow (1906) for this remarkably unstable genus. The scales along the edge of the gular fold are all smaller than those under the chin, and are of equal size throughout. The number of large, transverse scales in front of the forearm run from 6 to 9. The femoral pores are 19 in one thigh, 20 in five, 21 in six, 22 in nine, and 23 in seven of the thighs in which counts could be made; being 23 right: 23 left twice, 23:22, ♂ 22:23, ♂ 22:22 three times, 22:—, 21:22, 21:21, 20:21 three times, 20:20, and 19:—. The femoral pores are large in four, medium in six (at least two of which are males), and small in five specimens.

Light, almost wholly unspotted, specimens were taken on the glaring sand south of Blythe Junction. The throats in these are cream-colored and much lighter than in other specimens; and the sides of the head are yellowish and show no dark markings. Other specimens collected among dark rocks, in washes, and on rocky hillsides exhibit the bluish gray throats, dusky shoulders, and yellowish hind quarters typical of the species. The areas between the darker spots on the neck, and the spot in front of the ear (light yellow in *C. stejnegeri* and in *C. tigris undulatus*), are in the present series dusky, and in many specimens this dusky suffusion obscures the darker markings on the sides of the neck. The dorsal spotting, striping and cross-banding seems to occur rather indiscriminately among both large and small individuals. The examples from sandy areas, as before noted, have the dorsal pattern almost obliterated. The dorsal black dashes in some of the others are in six to eight longitudinal series joined obliquely to form zigzag stripes, with the yellow ground color showing as longitudinal lines be-

tween. In other examples the black longitudinal lines are broken up into squarish patches, and in a few these patches are joined transversely in the posterior region giving a tiger-like banding.

Museum number	5513 ♂	5516 ♀
Total length (in millimeters)	335	309
Tail length (in millimeters)	246	220
Length of fourth toe (in millimeters)	25	23

The whip-tailed lizard seems to occur abundantly in the Turtle Mountain vicinity in every phase of environment, except the rocky mesa, from rocky hillside to sand dune (see table, p. 507). It was especially well represented over the rocky hillsides, where individuals ceaselessly forage, sticking their sharp noses into little piles of leaves and debris or picking up small bits of food with their active tongues. They slink about hesitatingly on the sand, with their tails dragging behind them, thus leaving a characteristic track. When running swiftly this lizard elevates its tail, so that the ground is just cleared; and the tip lashes about as the lizard runs.

Though usually timid, the whip-tails, like *Callisaurus,* seem to be almost devoid of fear when feeding. I saw two come into a room and gather crumbs from the floor while several people were about. They sometimes rest with their hind feet raised clear of the hot sand. They exhibit a tendency to burrow with their forefeet when annoyed.

The stomach of one whip-tail contained a large grasshopper, slightly chewed. Another had eaten a small beetle, a spider, and a quantity of tiny yellow ants.

Sonora episcopa (Kennicott)

Texas Ground Snake

The one specimen (no. 5549) was taken in the rocky hills four miles northwest of Blythe Junction. So far as known to the writer, this is the first record of this snake from California. The scales are in 15 longitudinal rows, the loreals are 1–1, the gastrosteges 185, the urosteges 50, the total length 405 millimeters, and the tail length 73 millimeters.

The coloration differs slightly from that given by Van Denburgh (1912, pp. 153–154) for two specimens collected at Yuma, Arizona. The head is orange (a variation also recorded by Brown, 1901) instead of the usual yellowish brown color, and is identical in tone with the "vinaceous rufous" dorsal band. The darker patches on the head

are only barely distinguishable. The dorsal stripe is three whole and two half scales wide on the body, and two whole and two half scales wide on the tail. The orange colors have turned to light pink after nine months immersion in alcohol. In the adoption of the scientific name of this and the next following species the present writer follows Van Denburgh and Slevin (1913, p. 411).

The specimen captured was found on June 8 at six P.M., coiled beside a stone in front of a hole, into which it abruptly disappeared when approached. The red colors were conspicuous in the living snake from the moment it was discovered. The stomach was apparently empty.

Sonora occipitalis (Hallowell)

Desert Burrowing Snake

The two specimens secured (nos. 5547, 5548) were the only examples of this species noted. In each the body scale rows are 15 and the loreals 1–1; other features as follows:

Nos.	Gastrosteges	Urosteges	Black bands on body	Black bands on tail	Total length in millimeters	Tail length in millimeters
5547	161	46	31	9	104	36
5548	163	41	32	10	318	53

The life-colors of this species (see Richardson, 1910, p. 383) have faded more quickly and completely in alcohol in the present specimens than in any of the other reptiles in the collection. The yellow and red bands are now, after nine months, entirely white, although the specimens have been kept in the dark.

Two of these docile little snakes were found on the gravelly, creosote-dotted plains south of Blythe Junction. One was taken late in the afternoon, the other early in the morning, and neither was active. One was caked with clay as though it had just emerged from the soil. Mr. H. A. Smith of Blythe Junction, to whom I showed one of the above examples, said he once found one of these snakes in the hard soil of his yard and some distance below the surface.

Lampropeltis boylii (Baird and Girard)

Boyle King Snake

The only specimen taken (no. 5543) shows no trace of longitudinal striping as in "*californiae*" from San Diego, Riverside, San Bernardino (Waterman Cañon), and Fresno counties. A very few of the

white scales on the sides are narrowly bordered posteriorly with brown; this may indicate a leaning toward the *conjuncta* type, described from Cape San Lucas and Yuma, Arizona (Van Denburgh, 1895, pp. 142, 143).

In the Blythe Junction specimen the loreals are distinct, there are two postoculars, the anterior temporals are three on each side, and there are nine inferior labials, of which the fifth is the largest. The scale rows are 23–21, the gastrosteges 256, and the urosteges 54 (all divided). The total length is 912 millimeters, and the tail length is 115 millimeters.

The rostral plate is yellowish, margined above with brown. All the other parts are dark brown and white. The color pattern is typical. There is a small white patch on the middle of the nape one scale behind the parietals. The body is encircled with thirty-five white rings and the tail with eight.

Only the one "milk snake" was seen in the Turtle Mountains. It was found on May 30, crawling over the rocks in a cañon bottom at about nine o'clock in the morning. An example of this species, taken in the river bottom (arrowweed association) at Needles, on July 15, 1909, was trying to swallow head-first a harvest mouse (*Reithrodontomys*) caught in a "gee-whiz" mouse trap.

Bascanion flagellum frenatum Stejneger

Red Racer

Two specimens of this variable form are at hand (nos. 5545, 5546). The scales are in 17 rows in both, and in each the anal plate is divided. Loreal fused with posterior nasal on each side in no. 5546; partly fused on left, distinct on right side, in no. 5545. Other characters as follows:

No.	5545	5546
Superior labials	7 right, 9 left	8
Inferior labials	11	11
Gastrosteges	201	207
Urosteges	110	111
Total length (millimeters)	1291	1237
Tail length (millimeters)	341	327

Color descriptions of this subspecies by Cope (1898, p. 801), Stejneger (1893, pp. 208–209), and Van Denburgh (1897, p. 187) taken probably from preserved material, do not mention the vivid red color of this snake. In both of the present examples there are traces of at

least three black cross-bars on the nape, and no. 5545 has a series of lighter scales in regular transverse intervals down the back on the anterior half of the body. Both specimens are heavily marked with brown and red spots about the face, neck, and throat.

The red racer seems to be the most generally distributed snake on the Colorado Desert. It occurs on mountain and plain alike, and is far swifter in movement than any other desert snake. The two present examples were taken at the Horn Mine near a tent floor under which they had apparently been living.

Crotalus mitchellii (Cope)

Pallid Rattlesnake

Three specimens (nos. 5540, 5541, 5544) of this desert species were captured near the Horn Mine. In scutellation and coloration these examples show departure from some of the typical characteristics of *mitchellii* and seem to approach to a certain extent those of *tigris*. In no. 5540 the rostral is in contact with the anterior nasals on both sides, but on the left a small scale has started to split off from the nasal between the latter and the rostral. In the other two specimens the rostral is separated from the anterior nasals by one row of three scales on each side. Rostral higher than wide in no. 5540, equilateral in no. 5544, and wider than high in no. 5541. Scales on body all keeled; in 23 rows in no. 5541, and in 25 rows on the other two specimens. Supraoculars striate and rugose. Three rows of scales between suborbital chain and labials. Other characters as follows:

Museum Number	5540	5541	5544
Rows of scales between supra-oculars	7	6	5
Superior labials	17	15	16
Inferior labials	16	17	17
Gastrosteges	179	183	179
Urosteges	18†	21†	19‡
Total length (in millimeters)	653	773	616
Tail length (in millimeters)	41	55	47

† Last one divided.

‡ First and last three divided.

The color varies widely. In no. 5540 the transverse bands of ground color are light pink, the muzzle greenish, the top of the head pinkish yellow speckled with yellow, and the sides of the head gray over the temporal region and corner of the mouth; dark patches on

back indistinct, brown; sides gray; a few scales surrounding darker patches on back, bluish gray; underparts whitish; a broad light subocular stripe including six of the upper labials.

No. 5541 has more red in the coloration of the sides, and the lighter dorsal bands are flesh pink. Gray predominates in the dorsal coloration, and the pink ground color becomes tawny on the posterior end of the body. Distinct reddish brown bands on posterior third of the body; anteriorly each of these bands splits into three transverse blotches, the outer two being small, and the middle one large as in *tigris*. Belly white; lateral edges of gastrosteges in median abdominal region speckled with red and gray. Light area below eye, covering five upper labials. No. 5544 is in the red phase. The coral red of the top of the head and back almost obscures every other marking, but the dorsal bands can be made out because of their darker shade, near russet vinaceous. The pink color becomes yellowish near the tail; the latter is marked by seven fairly distinct blackish bands which do not meet below. The sides and top of the head are obscurely stippled with gray. No light markings below or behind eye. In all three specimens the sides of the head do not exhibit the postocular stripe common to so many species of rattlesnakes (see Stejneger, 1895, pp. 423–424).

Only the three pallid rattlesnakes taken were seen; two of these were in a rocky wash at the Horn Mine, and one (no. 5541) was beneath a dead palo verde in a wash about a mile from the foot of the mountains. The stomach of no. 5544 contained a Stephens cañon mouse (*Peromyscus crinitus stephensi*). Since this rodent is wholly nocturnal, the instance might be taken as showing nocturnal habits on the part of the snake.

Crotalus cerastes Hallowell

Sidewinder

One horned rattlesnake (no. 5542) was captured in the drifting sand near Blythe Junction. This specimen has the anterior and posterior nasal plates divided on the right side and united on the left. One internasal is present on each side. There are 13 superior and 13 inferior labials, 143 gastrosteges, and 24 urosteges of which the posterior four are divided. The total length to the base of the rattle is 504 millimeters, and the tail length 39 millimeters. There is a wart-like growth on one side near the neck, consisting of eight elongated scales arranged in rosette fashion.

The writer is by no means convinced that this rattlesnake is exclusively nocturnal in habits as suggested by Meek (1905, p. 18). Both at Needles and near Blythe Junction individuals were traced by the characteristic tracks in the sand. Each was found closely coiled in a symmetrical pad and partly buried flush with the surface in the hot sand right out in the noonday sunshine of midsummer. In neither case were the snakes easily seen, as they were of the exact color of their sandy surroundings. Both, though alert, allowed themselves to be noosed without moving away or doing more than rattle feebly. That they eat the diurnal lizards *Uta* and *Cnemidophorus* (see Van Denburgh and Slevin, 1914, p. 429) is an evidence of daytime activity.

Transmitted August 20, 1915.

LITERATURE CITED

Atsatt, S. R.

1913. The reptiles of the San Jacinto area of southern California. Univ. Calif. Publ. Zool., **12**, 31–50, 2 tables.

Brown, A. E.

1901. A review of the genera and species of American snakes north of Mexico. Proc. Acad. Nat. Sci. Phila., **53**, 10–110.

Bryant, H. C.

1911. The horned lizards of California and Nevada of the genera *Phrynosoma* and *Anota*. Univ. Calif. Publ. Zool., **9**, 1–84, pls. 1–9, 6 figs. in text.

Cope, E. D.

1898. The crocodilians, lizards and snakes of North America. Rep. U. S. Nat. Mus., **1898**, 151–1294, 36 pls., 347 figs. in text.

Coues, E.

1875. Synopsis of the reptiles and batrachians of Arizona with critical and field notes and an extensive synonomy. *In* Wheeler, G. M., Report Geogr. Geol. Expl. and Surveys West of 100th Meridian, **5**, pp. 585–633, 10 pls.

Ditmars, R. L.

1907. The reptile book (New York, Doubleday, Page & Co.), xxxii + 472, 136 pls.

Franklin, D

1913. Color changes in collared lizards. Copeia (New York), **1**, no. 1, Dec. 27, 1913.

1914. Notes on leopard lizards. *Ibid.*, **1**, no. 5, April 15, 1914.

Gadow, H.

1906. A contribution to the study of evolution based upon the Mexican species of *Cnemidophorus*. Proc. Zool. Soc. London, **1906**, 277–375, 1 pl., 22 figs. in text.

Grinnell, J.

1908. The biota of the San Bernardino mountains. Univ. Calif. Publ. Zool., **5**, 1–170, pls. 1–24.

1914. An account of the mammals and birds of the lower Colorado valley with especial reference to the distributional problems presented. *Ibid.*, **12**, 51–294, pls. 3–13, 9 figs. in text.

Grinnell, J., and Grinnell, H. W.

1907. Reptiles of Los Angeles County, California. Throop Inst. Bull. (Pasadena, Calif.), no. **35**, 1–64, 23 figs. in text.

Meek, S. E.

1906. An annotated list of a collection of reptiles from southern California and northern Lower California. Field Mus. Publ., Zool. Series, **7**, 1–19, 3 pls., 1 table.

Richardson, C. H.

1910. Notes on a little-known species of snake, *Chionactis occipitalis*. Science (n. s.), **32**, 383–384.

1915. Reptiles of northwestern Nevada and adjacent territory. Proc. U. S. Nat. Mus., **48**, 403–435.

Ruthven, A. G
1907. A collection of reptiles and amphibians from southern New Mexico and Arizona. Bull. Amer. Mus. Nat. Hist., **23**, 483–603, 22 figs.

Stejneger, L.
1890. Annotated list of reptiles and batrachians collected by Dr. C. Hart Merriam and Vernon Bailey on the San Francisco Mountain Plateau and Desert of the Little Colorado, Arizona, with descriptions of new species. U. S. Dept. Agric., Div. Ornithology and Mammalogy, N. Amer. Fauna, no. **3**, 103–118.
1893. Annotated list of the reptiles and batrachians collected by the Death Valley expedition in 1891, with descriptions of new species. *Ibid.*, **7**, 159–228, 394–398, 4 pls.
1895. The poisonous snakes of North America. Rep. U. S. Nat. Mus., **1893**, 337–487, pls. 1–19, 70 figs. in text.

Stephens, F.
1914. Arid California and its animal life. Biennial Rep. Calif. Fish and Game Comm., **3**, **1912–1914**, 127–135, 2 figs. in text.

Stone, W.
1911. On some collections of reptiles and batrachians from the western United States. Proc. Acad. Nat. Sci. Phila., **43**, 222–232.

Stone, W., and Rehn, J. A. G.
1903. On the terrestrial vertebrates of portions of southern New Mexico and western Texas. *Ibid.*, **55**, 16–34.

Taylor, W. P.
1912. Field notes on amphibians, reptiles and birds of northern Humboldt County, Nevada, with a discussion of some of the faunal features of the region. Univ. Calif. Publ. Zool., **7**, 319–436.

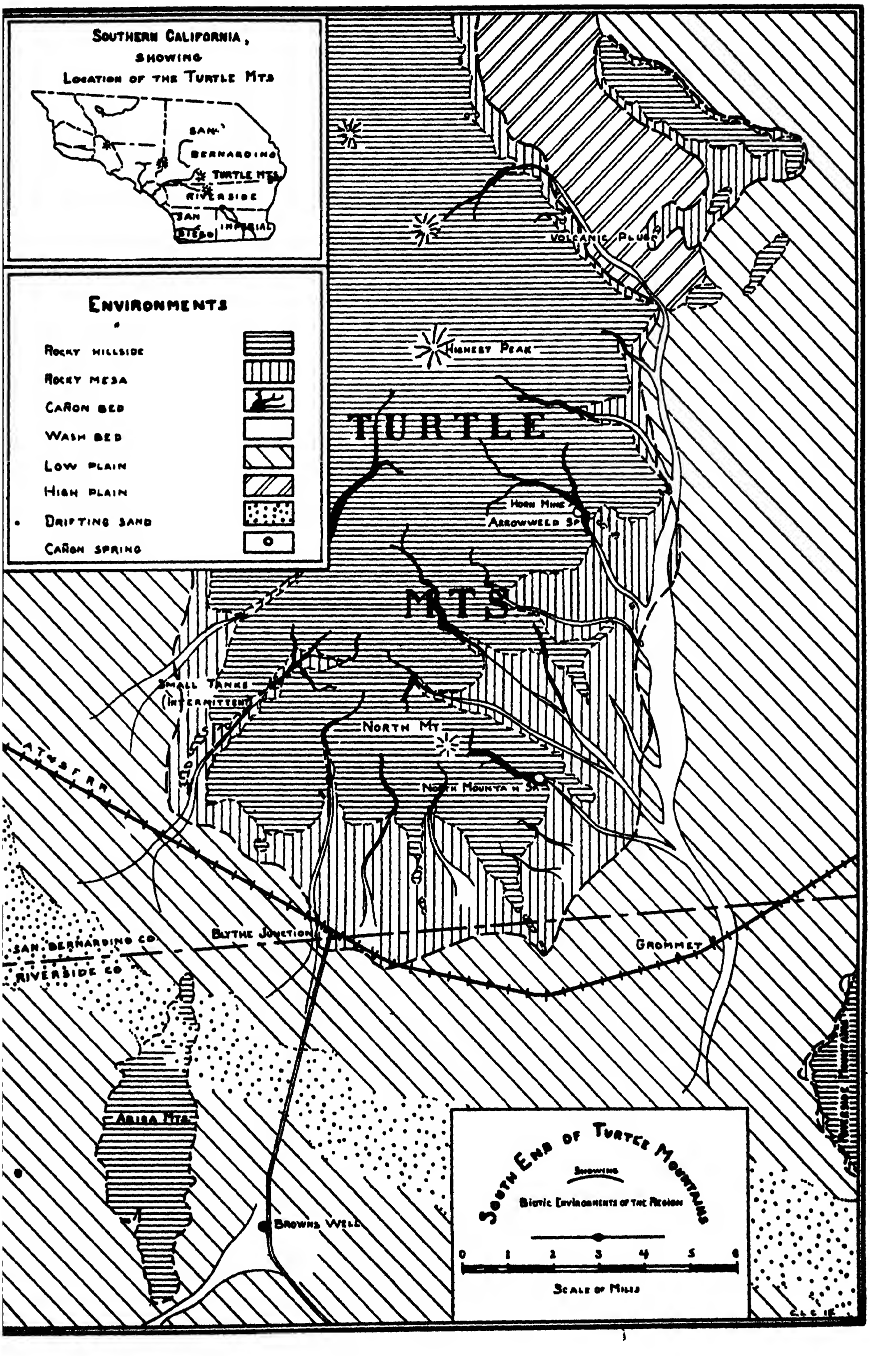
Van Denburgh, J.
1895. A review of the herpetology of Lower California. Part I, Reptiles. Proc. Calif. Acad. Sci. (2), **5**, 77–162, 11 pls.
1897. The reptiles of the Pacific Coast and Great Basin. Occasional papers, Calif. Acad. Sci., **5**, 1–236, many figs. in text.
1912. Notes on a collection of reptiles from southern California and Arizona. Proc. Calif. Acad. Sci. (4), **3**, 147–154.

Van Denburgh, J., and Slevin, J. R.
1913. A list of the amphibians and reptiles of Arizona, with notes on the species in the collection of the Academy. *Ibid.*, (4), **3**, 391–454, pls. 17–28.

Yarrow, H. C
1875. Report upon the collections of batrachians and reptiles made in portions of Nevada, Utah, California, New Mexico, and Arizona during the years 1871, 1872, 1873, and 1874. *In* Wheeler, G. M., Report Geogr. Geol. Expl. and Surveys West of the 100th Meridian, **5**, pp. 509–584.
1882. Check list of North American reptilia and batrachia, with catalogue of specimens in U. S. National Museum. Bull. U. S. Nat. Mus., **24**, 3–249.

PLATE 19

Map of Turtle Mountain region, southeastern California, showing animal environments.



Southern California, showing Location of the Turtle Mts
San Bernardino
Turtle Mts
Riverside
San Diego
Imperial
Environments
Rocky hillside
Rocky mesa
Cañon bed
Wash bed
Low plain
High plain
Drifting sand
Cañon spring
Volcanic Plug
Highest Peak
TURTLE
MTS
Horn Mine
Arrowweed Sp
Small Tanks (Intermittent)
North Mt
North Mountain Sp
A T & S F R R
Blythe Junction
Grommet
San Bernardino Co
Riverside Co
Arica Mts
Browns Well
South End of Turtle Mountains
Showing
Biotic Environments of the Region
0 1 2 3 4 5 6
Scale of Miles

PLATE 20

Fig. 2. High plain environment near volcanic plug at south end of Turtle Mountains, San Bernardino County, California. *Yucca mohavensis* in foreground and middle distance.

Fig. 3. Low plain environment near Blythe Junction, Riverside County, California. *Dipodomys deserti* burrows in foreground, sand dunes in distance.

Fig. 2

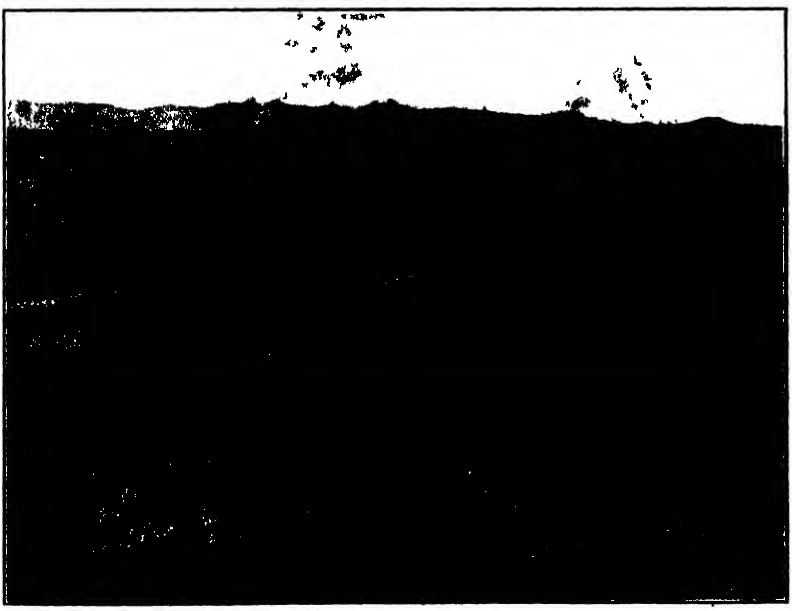


Fig. 3

PLATE 21

Fig. 4. Drifting sand environment near Blythe Junction, Riverside County, California. Home of *Uma notata*; kit fox scratchings, and burrows of *Citellus tereticaudus*, in foreground.

Fig. 5. Small wash in rocky mesa environment at south end of Turtle Mountains. Caves in foreground inhabited by *Neotoma*, and by *Sceloporus magister*.

Fig 4

Fig. 5

PLATE 22

Fig. 6. *Uma notata,* from specimens. Dorsal view from no. 1285, Mus. Vert. Zool.; ventral view from no. 1286, Mus. Vert. Zool.

Fig. 7. *Uma notata,* from life, showing posture when alert

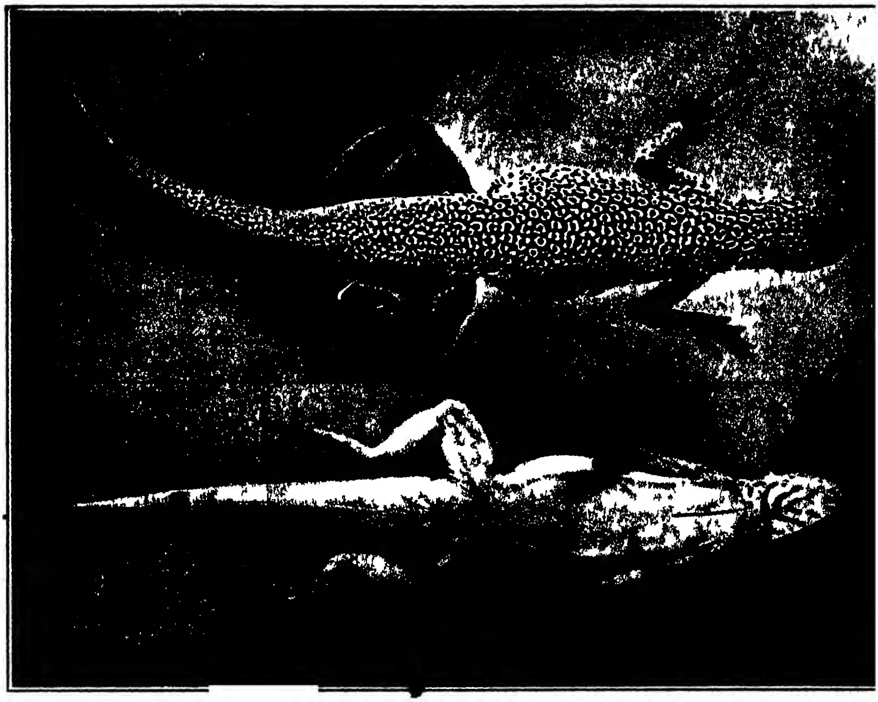


Fig 6

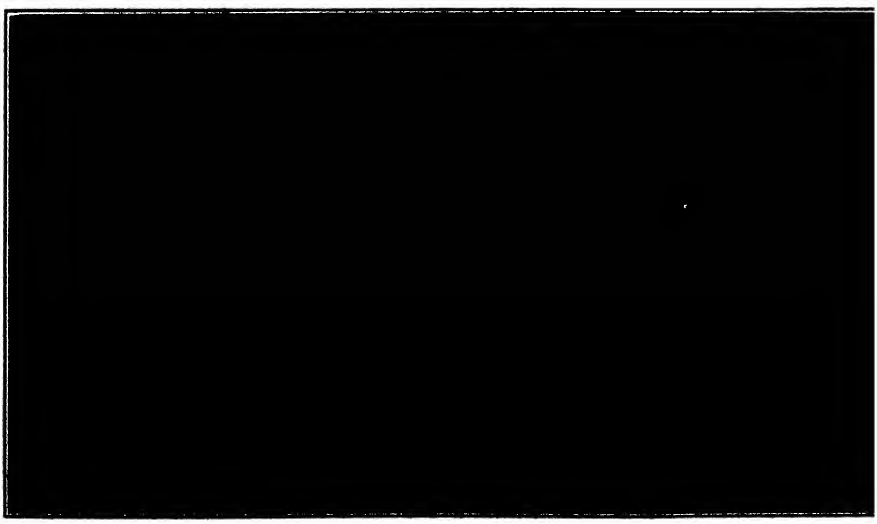


Fig. 7

INDEX*

Titles of papers in this volume, and names of new species, are printed in a **bold-faced** type

* Univ. Calif. Publ. Zool., vol. 12.

ERRATA

Page 441, line 5 from top. *For* scalded *read* scaled.

Page 476, line 11 from bottom. *For* transversing *read* traversing.